CHANGE GEAR DEVICES

PERRIGO

Owen E. Kenyon

Change Gear Devices

▼ ▼ ▼

SHOWING THE DEVELOPMENT OF THE SCREW CUTTING LATHE AND THE METHODS OF OBTAINING VARIOUS PITCHES OF THREADS.

▼ ▼ ▼

BY

Oscar E. Perrigo

▼ ▼ ▼

First Edition

1903

New York

The Locomotive Publishing Co., Ltd.

London

THE NORMAN W. HENLEY PUBLISHING CO.

132 NASSAU STREET,

NEW YORK

Preface

Some time ago the author had occasion to make a more or less exhaustive examination of the subject of Change Gears for engine lathes, and the development of the devices for this purpose as represented by the existing patents which have been granted for the same. The search was one of long and arduous study and labor, and the subject seemed to possess sufficient interest to legal and mechanical men to warrant the publication of the results in such a permanent form that it might be preserved as a convenient and concise book of reference on this subject.

Most of the matter has been published in the columns of "Machinery," and has received the kind commendation of many thoughtful men.

There were one hundred and sixty-four patents examined, and out of this mass, twenty-nine were selected as bearing directly upon the Change Gear problem; the others being for forms of variable speed devices and similar inventions, not properly coming under the head of the Evolution of the Change Gear.

These twenty-nine patents have been very carefully considered and described, their special or distinguishing features illustrated and compared in a conscientious and disinterested manner, which it is hoped, will prove both instructive and useful to those who may be interested in this field of mechanical development.

OSCAR E. PERRIGO.

New Haven, Conn., September, 1903.

Introduction

The question of the change gears for lathes and the great amount of time and inventive genius that has been devoted to the matter in the last few years would seem to render the subject one of considerable interest to the men who design lathes, the manufacturers who build them, the men who buy or use them, and the men who are interested in the obtaining of patents upon their various and almost multitudinous devices.

The matter has been taken up with the view to ascertaining what there may be in this line which has been secured in the United States Patent Office; to give diagram illustrations of the prominent features of each device in itself, and to compare and contrast its various claims to usefulness, both in a commercial and in a practical way, with other inventions of its class.

It is undoubtedly true that there may be very commendable devices on the market to-day, put forth on a quasi claim of being patented, which have never seen the inside of the Patent Office, except possibly to be put on the immense list of rejected applications.

The careful and methodical reader is assured that although the copies of no less than one hundred and sixty-four patents have been considered, covering as they do many phases of variable speed mechanism, the twenty-nine patents hereinafter described and illustrated contain all of the subject matter from the patent of Bancroft and Sellers in 1854 to that of Newton, May 19, 1903.

And in reviewing these various patents the first

consideration has been to get at the *germ* of the invention, to illustrate its good points "for all they are worth," and in comparison with others to give all due credit which the mechanical knowledge of the writer feels to be fair and just. If inventors feel their devices are underrated they are heartily assured that there is no desire to in any way belittle their work, but rather to bestow "honor where honor is due."

It would seem appropriate just here to mention some of the points which impressed themselves on the mind of the writer during the long and careful consideration of this subject. Of course it is expected that there will be those who will not agree with the writer's opinions or deductions as to the construction or merit of the various inventions. To these good people there is one thing to be said. It is this. It is a most difficult undertaking to describe and analyze this number of patents, representing, in some cases, ideas so nearly similar as to be very difficult to decide their respective merits or similarities, or again, the subject of antagonistic interests, each supposed by their partisans to embody the only proper construction.

In all these perplexities, however thorough and painstaking a writer may desire to be in his work, and however anxious he may be to do exact justice to all, "it is impossible to suit everyone," and consequently that effort was discarded in the beginning.

One of the features in patent drawing which strikes a practical mechanic very forcibly is that very few of the drawings are so made that even an operative model could be made from them, much less a practical working machine, without supplying much in the way of mechanical detail and design.

Various views and groups of parts are found utterly

impossible to assemble as they are drawn. Sometimes in two adjacent views one is reversed and not a similarity of form or the presence of reference letters show the fact.

In one case a sliding piece was required to move fifteen inches and had formed upon it a rack which could not be cut with over three teeth to an inch, and this was operated by an an eight-tooth pinion on the end of whose shaft was a lever which could move only through an arc of 90 degrees, hence the rack would move less than an inch instead of fifteen inches. And so on *ad infinitum.*

It frequently happens that inventors are not practical men from a commercial point of view. Their devices may possess merit, but it is frequently so covered up with unnecessary complications (by machinists called "traps"), that they are of little commercial value until these idiosyncrasies are eliminated by a practical man who has the ability and foresight to seize the germ of the invention and to so arrange the construction of the device as to make it of real commercial use and value. This frequently amounts to the mechanic making almost the entire invention, and in reality to his rendering it of practical value. At the same time he seldom gets any credit for what his mechanical ability has produced.

Some Lathe History

From time immemorial it has been one of the vexing questions in the blacksmith shop as to which was the first of the blacksmith's tools, the hammer or the tongs. If the question was asked, which one of the machines was first used in the machine shop, nearly every machinist would unhesitatingly say, the lathe.

And while the lathe is also probably the oldest of machine tools, it is the most important in many respects to-day. Many of the other machine tools might be spared and the work done in some other way. But the lathe is the one indispensable machine that the machinist *must* have. With it he can turn, bore, face, mill, plane, slot, and in fact do almost every kind of work done by any machine tool in the shop. It is verily the king of the machine shop tools. And yet, while it is probably the first machine tool devised, it is only in comparatively recent years that it has arrived at anything like its present state of perfection.

In considering the subject of change gear devices for lathes it may be well to refer briefly to the early history of turning lathes and then to their later development, not only of the devices for thread cutting, but of the lathe itself.

Going back to the early history of the lathe, we know that Theodorus of Samos, B. C., 560, is said by Pliny to be the inventor of turning, but while many believe that this species of "turning" perhaps referred to the "Potter's Wheel," used in forming clay into circular vessels, it is

undoubtedly true that the "Potter's Wheel" was known centuries before, since it is several times spoken of in the Old Testament.

It seems to be a fairly well conceded fact that the first turning lathe ever devised was a very crude affair and consisted of a spindle pivoted to two trees or to blocks fastened to the trees and propelled by a cord whose upper end was attached to a flexible limb of one of the trees, from whence it passed down to the spindle, took a turn around it, and then continued down to a treadle to which the power was applied.

Later on a spring-pole took the place of the flexible limb, and the lathe was dignified by having a bed, or rather a frame for its support, instead of the two trees. By the use of the cord and foot treadle the rotation of the work was forward when the foot was pressed down, but reversed as the foot came up. This disadvantage seems to have been partially overcome by adding a balance wheel to the lathe spindle, or to the work, which kept up the forward motion as the power exerted by the foot ceased on the upward movement. It was, however, necessary to draw the tool back from the work during this time as the momentum was not sufficient to oppose much resistance.

Then the idea of a crank may have been conceived and the lathe propelled by an assistant. Also, some sort of pulleys, most likely grooved ones, were discovered and the convenience of increased speed made possible.

Thus far it is likely that the use of the lathe was for turning articles of wood or ivory, but it was not a long step to turning articles of metal. Thus these simple mechanical contrivances were devised for the use of the early mechanics, who in their gradual improvements must have

hit upon the idea of screw threads for bolts used in fastening their work together.

While it is probable that Archimedes, B. C., 287, had an idea of the form of a screw it was a long while after his time before the idea was applied to the formation of screw threads as we know them to-day.

It is probable that the first screw threads were made on wood and that they were "chased" with a hand tool.

Following up the history of the lathe from its crude beginning, we find that in 1569, one Jacques Berson, a Frenchman, made a lathe that was capable of cutting threads on wood. He located a large wooden lead screw above the lathe spindle, and in it engaged a "half nut" supported in a frame, in which was journalled the wooden blank on which the screw was to be cut. Both the lead screw and the blank were rotated by cords, as in the "spring-pole" lathe, from a shaft overhead. A fixed tool cut the thread as the blank was rotated by the cord and drawn forward by the lead screw and sliding frame.

In 1680 Joseph Moxan made and sold lathes in England. It is not known that they would cut any kind of a thread, either on wood or metal.

The French Encyclopedie of 1772, exhibits an illustration of a lathe which contains a crude arrangement for holding the tool, which shows a faint idea of a slide rest, although the slide rest, in an operative form, is supposed to have been invented by Henry Maudslay, in England, in 1794.

One of the early French lathes is represented as having an arbor upon which is cut a number of short sections of thread of different pitches. The manner of using this arbor is not made clear, but was, most likely, a crude

arrangement somewhat after the well known device of the "Fox" brass lathe for thread chasing.

The slide rest, however crude, relieved the workman from the fatigue of holding the tool by hand, and yet the idea does not seem to have become popular for many years after.

Lathes propelled by foot power and having the treadle, cord and spring-pole, were in use for years during the first quarter of the nineteenth century, and some as late as 1860.

Following along in the gradual development of mechanical devices threads were cut on metal, "chasers" still being used for this purpose. With the crude hand tools then in use, this was a very slow and laborious process until some genius more far seeing than his fellows developed the idea of cutting a thread from one already made, on the principle of the "gauge lathe."

This idea is illustrated in the accompanying sketch, Fig. 1, in which such a lathe is shown in plan, and in which *A* is the screw already cut; *B* is the piece to be threaded, adjusted in proper supports and the one driving the other; a slide carrying at one end a former point, *C*, engaging the thread and at the other a cutting tool, *D*, for chasing the thread. From this device doubtless proceeded the idea of making the screw a permanent part of the lathe, with a nut which was attached to the sliding part, or carriage. This had been preceded, probably, by other means of moving the carriage for plain turning, such for instance as the old time "chain feed." The "master screw," "traveler screw," or "lead screw," as it was variously called, was for a long time placed at the back of the bed and in the earliest examples was revolved by gearing made by inserting pins in the face or in the

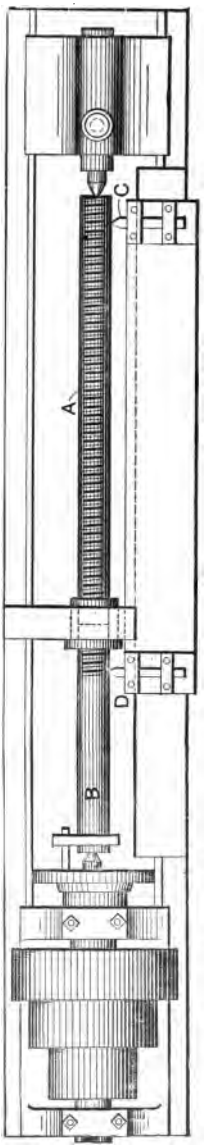


Fig. 1. An Early Method of Cutting Threads.

edge of wheels or disks. It is altogether probable that for a long time only one pitch of thread was cut by a "master screw," and that when another pitch had to be cut another "master screw" was required, as the "master screw" revolved at the same rate of speed as did the head spindle of the lathe.

Then followed the idea of revolving the "master screw" at a different rate of speed from that of the spindle for the purpose of cutting a different pitch of thread from that of the "master screw." When this was once done, it was easy to see that if two pitches of thread could be cut with one "master screw," any other number of threads might be cut by similar means.

In order to cut both right and left-hand threads, as well as to conveniently bring the change gears into engagement with each other, the stud plate (or "quadrant," "swing plate," "yoke plate," etc., as it has been variously called), was devised, with its stud for idle gears and an extra stud for the gear necessary for reversing the motion of the lead screw in cutting left-hand threads. Thus the well known change gears and adjustable stud plate came about and did good service for many years.

But the restlessness of mechanics and the ever-present desire for improvements in time led investigating workmen to look for some method by which to avoid even the small labor and inconvenience of changing the gears when a different thread was to be cut.

The writer remembers an old shop in the country where, in a certain form of woolen spinning devices a worm and worm gear was wanted and it was made by wrapping a piece of paper around the turned cylinder which was to be the screw, and cutting through this with a knife so that it would become the exact development of the surface of the

cylinder. This paper was then laid off for the pitch as shown in Fig. 2. It was then glued around the cylinder and the diagonal lines became the developed screw thread. Then with a fine saw, a chisel and a file the thread was cut in a proper V form. The wooden wheel was spaced off and the teeth cut in a similar manner, not with a curved pitch line, of course, but straight, as in a spur

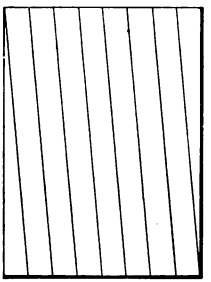


Fig. 2. Development of Screw Thread.

gear. It was surprising what an amount of wear these crude worms and wheels would stand.

This method of laying off a screw thread appears to have been discovered, or at least first made use of, so far as we know, by Anthony Robinson, in England, in the year 1783, when he made a triple threaded screw six inches in diameter and seven feet six inches in length. He first laid out one of the three threads in this manner and worked it out by hand, after which it was used as a guide by which to cut the other two by power.

In order to illustrate some of the earlier forms of

lathes the one on this page is shown. This lathe was probably built about 1830 and was the property of an old Scotch mechanic named Rea, who had a shop about four miles from Plattsburgh, N. Y.

The bed was composed of two oak timbers about 5 x 12 inches, bolted to wooden legs, as shown. On the inside of each timber a rabbit was cut, in which were fastened flat bars of wrought iron, set with the edges up, and about $\frac{5}{8}$ x 3 inches, the upper edges being chipped

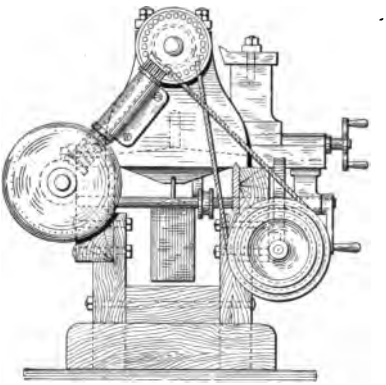


Fig. 3. End View of Figure 4.

and filed to answer for Vs. The head stock was cast with pockets of square form for the boxes, which were fitted by filing, and also had threaded studs of wrought iron cast in the head for holding down the caps over the boxes. The boxes were cast of some sort of composition resembling babbitt metal. The spindle was of wrought iron and carried a wooden cone of three steps built upon a cast-iron flange keyed to the spindle.

The tail stock was very light and had on the rear end

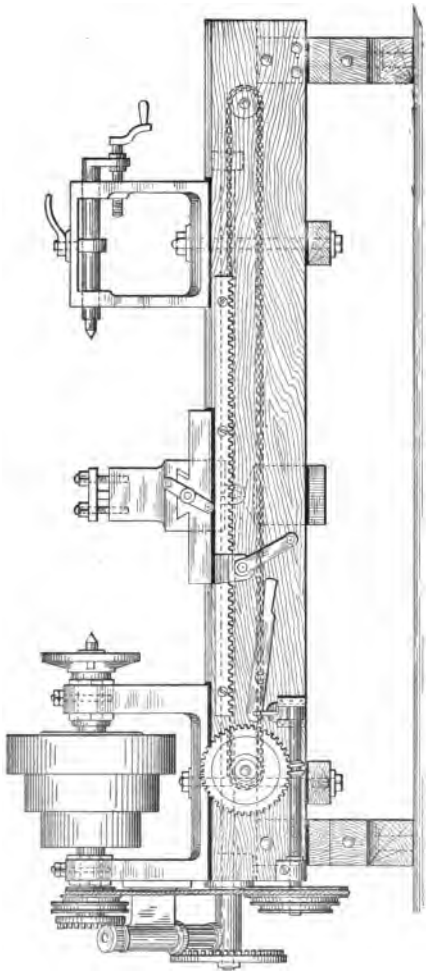


Fig. 4. The Old Time Chain Lathe.

of its spindle a downwardly projecting part, slotted to receive the tail screw, which was provided with a crank forged upon it. Both head stock and tail stock were held in place by a single bolt each, passing down through wooden binders (not shown in the cut).

The carriage was fitted to the same Vs as the head and tail stocks and had no more pretense to an apron than a bracket carrying a cast-tooth pinion meshing in a cast-tooth rack screwed to the front of the bed. The carriage was held down by a cast-iron weight as in all the old style of "weighted carriage" lathes.

A power feed was provided for by the use of a chain passing over two grooved wheels in which were pins for engaging the links of an ordinary "log chain." This was operated by a worm wheel with cast and chipped out teeth and a worm of only two or three turns of the thread. This was driven by grooved cone pulleys carrying a half inch round hand-made leather belt.

To stop and start this feed the end near the cone pulley was journalled in a pivoted box, and the other end supported in a vertically sliding box operated by a wooden lever which was conveniently hooked under a spike driven into the front of the bed. This feed mechanism was said to have been a comparatively recent addition to the lathe.

When the writer saw this lathe along in the beginning of the civil war it had an arrangement of change gears with cast teeth somewhat like the more simple lathes of to-day so far as its action was concerned; but hanging on the wall in the old shop and carefully treasured as relics of bygone days were the old "pin gears" and "lantern pinions" shown in the engravings. It was noticeable that one of these "lantern pinions" (the lower one in the engraving) was much longer than the other.

Used as late as 1875.

This was probably to accommodate different sizes of "pin gears" on the lead screw so as to cut varying pitches of threads.

This lathe was in practical use in 1875, and its old-time Scotch owner quaintly remarked, it was "able for monny a guid turn yet."

The Change Gear Patents

Recurring now to the gradual development of the lathe in reference to the thread cutting problem by the interchange of gears for producing varying pitches, and finally without removing or replacing "change gears," we come to the consideration of the actual evidences of what has been done, and the legal proof of the same as shown by the records of patents in the United States Patent Office.

In reviewing the mass of drawings, specifications and claims on these various points, covering the changes invented and proposed, we find many which are for the purpose of changing the rate of *feed* for ordinary turning, and these have been omitted as not properly concerned in the subject of "The Evolution of the Change Gear."

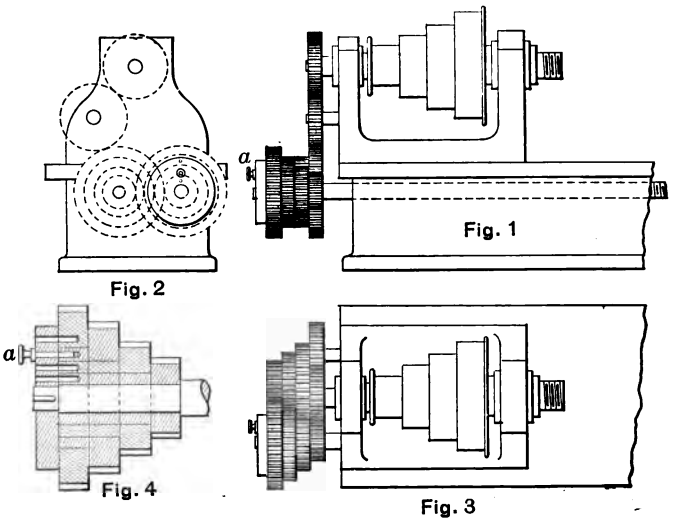
In presenting the drawings of patents to illustrate these articles, it will be noticed that they are in the form of diagrams only, showing in condensed manner the prominent features of the invention.

In some cases as many as four sheets of drawings are here shown in three or four views, for the purpose of simplifying the matter and economizing space. Gears are represented in side elevation by circles of heavy dotted lines and shaded to show their convex surface where the edge view is presented.

So far as we have any Patent Office records of the matter, the first serious attempt made to assemble all the change gears on one shaft appears to have been made by

The first attempt.

Edward Bancroft and William Sellers, of Philadelphia, Penn., who obtained patent No. 10,491, which was dated February 7, 1854. They placed the change gears directly upon the lead screw, the first or smallest gear having formed upon it a sleeve bored to fit the lead screw, and having fitted upon it the next gear having a like sleeve for



Edward Bancroft and William Sellers. No. 10,491, Feb. 7, 1854.

the following gear, and so on. These gears were all held in place by a disk fixed to the lead screw. Either of these gears could be in turn fixed to the disk by a pin passing through them both.

The arrangement in connection with the lathe is shown in the accompanying illustration, in which Fig. 1 is

a front elevation; Fig. 2, an end elevation, and Fig. 3, a plan of the Bancroft and Sellers lathe. Fig. 4 shows the manner of forming the gears with telescoping sleeves, and the fixed plate with its removable pin *a*, for bringing any desired gear into action.

The first claim of these pioneers in the change gear problem is worthy of careful consideration. It is as follows: "The method of varying the motions of the mandrel and screw-shaft or leader by means of two series of wheels, each series consisting of wheels of different diameters, and all of the wheels of one series being connected and turning together, and imparting motion to all the wheels of the second series with different degrees of velocity, substantially as described."

It will be observed that this claim practically anticipates several of the later devices which have been popularly supposed to be the first of the kind, and whose inventors have been given credit accordingly.

John Humphreys, of Chicopee, Mass., was apparently the next inventor who added much to the then "state of the art" as disclosed in his patent No. 83,774, which was granted November 3, 1868.

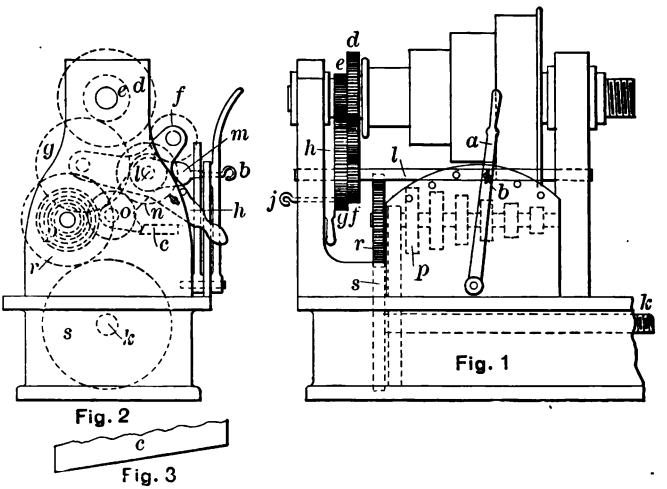
He appears to have followed Bancroft and Sellers in the idea which years later became so popular, for he says: "I place my gear wheels all on a shaft, ranging from the smallest to the largest, leaving a space between them of about the same width as the wheels themselves."

This space was provided so that his connecting pinion journalled in a "traveler" as he calls it, and could relieve itself from engagement with one gear before it came in contact with the next, as he had not provided for throwing it entirely out of gear before moving it laterally, as was done later.

John Humphreys' improvement.

Another feature apparently original with him, was that of obtaining an additional series of pitches by means of a yoke, pivoted on the same secondary shaft that his traveler worked upon, and having two idle gears journalled upon it, by which either a small gear or one double the size could be quickly brought into engagement with the gear on the secondary shaft.

Both these essential features of Humphrey's patent



John Humphreys. No. 83,774. Nov. 3, 1868.

have figured extensively in most of the later efforts in the attempt to provide for rapid changes of feed or from one pitch to another through a large number.

Fig. 1 is a front elevation of his lathe head, showing the shifting lever *a*, held at the desired point by the pin *b*. Fig. 2 is an end elevation showing the essential features. Fig. 3 is a development of the cam-shaped rack *c*, which

held the traveling pinion in contact with each gear of the cone of gears as it came into mesh with it.

The arrangement for multiplying or reducing the speed by gears of double the number of teeth is shown at *d, e, f, g,* journalled upon studs fixed in the yoke *h,* held in either position by the pin *j.* The lead screw *k* was placed within the bed. Upon the shaft *l,* both the yoke *h,* and the sliding lever *m* are journalled and the connecting pinion *n* is splined. The pinion *o* connects with the cone of gears *p,* from whose shaft *q* the gear *r* engages the gears on the lead screw *k.*

Three years after Humphreys' patent Frederick B. Miles, of Philadelphia, Penn., in patent No. 111,859, granted February 14, 1871, came still nearer to solving the problem by mounting all his change gears on the lead screw.

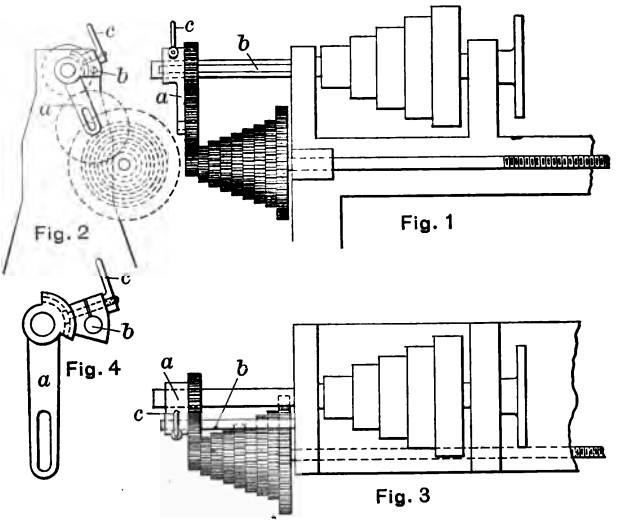
The end of the head spindle projected far enough beyond the rear box to carry a sliding gear controlled by a "traveler" as Humphreys called it, and having journalled on it an idle gear that might connect the sliding gear with any one of the change gears, at will. It was held in place by being clamped to a rod fixed in the head stock and parallel to the head spindle.

He also provided on the lead screw a gear much larger than the change gears for use as a feed gear for a turning cut, there being no feed rod provided for.

A front elevation is given in Fig. 1; an end elevation in Fig. 2; a plan in Fig. 3, and a detail of the bracket carrying the connecting pinion in Fig. 4. It is not likely from the construction that it was practical, as the torsional strain caused by the pressure of the gears of the cone of gears and the pinion on the head spindle with the connecting pinion would probably have wrecked the

device in a short time. But the *idea* was evidently there and only needed developing in a practical manner.

The drawing is so simple that it is only necessary to specify that the sliding bracket or arm seen in Fig. 4 is shown in position at *a*, Figs. 1, 2 and 3, and the supporting rod to which it is clamped is shown at *b*. This arm is



Frederick B. Miles. No. 111,859, Feb. 14, 1871.

secured in any desired position by the clamping lever *c* and its bolt.

William Bley, of Reesville, Penn., was the next man to record his ideas in the patent office. He did not add much to the subject, his modification being that of providing two supplementary shafts, upon each of which is mounted a set of change gears in reversed order. One set was fast to the shaft, while the other set ran loose on the shaft and

was in turn brought into action by a series of clutches splined to the shaft, each clutch serving for two gears. In this way about three and a half feet of space inside of the bed would have been required for a twenty inch swing lathe.

In the drawings, Fig. 1 represents a front elevation of the lathe; Fig. 2 is an end elevation, and Fig. 3 is a plan of the bed showing the arrangement of the supple-

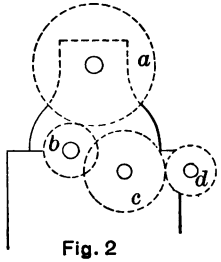


Fig. 2

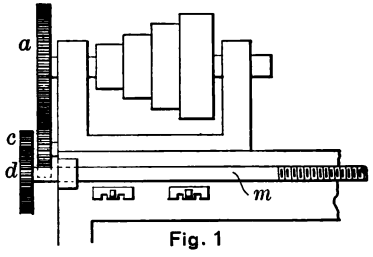


Fig. 1

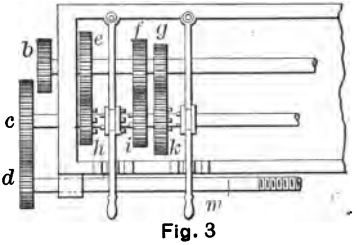


Fig. 3

William Bley. No. 156,758, Nov. 10, 1874.

mentary shafts, gears, clutches and the operating levers. The gears *h, i, k* run loose on their shaft and are connected with it as desired by the adjacent clutch. The gears *e, f, g* are fast to their shaft and are, of course, each driven by its opposite gear whenever the clutch is thrown into engagement.

Lacked a wide range.

The driving power to the lead screw is transmitted through the gears *a, b,* one of the gears *e, f, g,* and their fellows *h, i, k,* and the gears *c* and *d*. In an operative lathe there would need to be many more gears, as the arrangement shown would cut but three different pitches and two more gears would need to be added for each pitch. This would be an elaborate arrangement and scarcely practical, as may easily be seen.

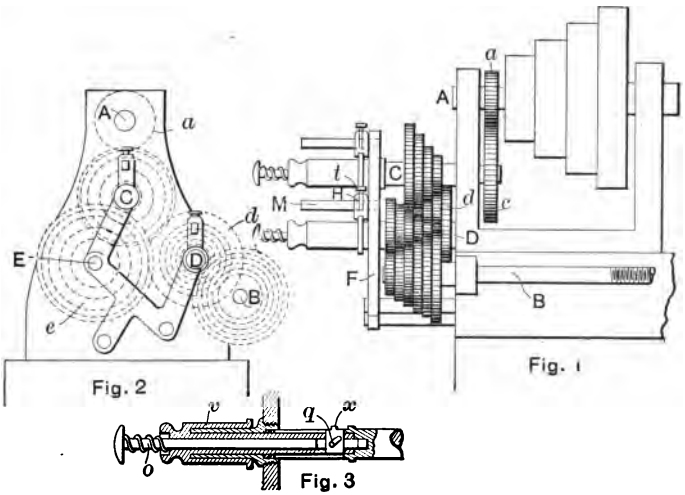
Charles William Riley, of Knoxville, Tenn., next tackles the change gear problem, and the results of his efforts are elaborately shown in the three sheets of drawing of Patent No. 233,702, granted October 26, 1880. If Humphreys had *one* set of change gears arranged in conical form, and Bley had *two,* Riley seems to have been determined to outdo them both by providing *four,* aggregating in all twenty-four gears, by which he could cut fifteen different pitches.

He makes this somewhat remarkable statement: "In a planing machine it has been proposed to use two intermeshing series of gear wheels, the wheels of one series running loosely on their spindle, and capable of being individually connected thereto at will." It does not seem that the proposed plan ever came into general use.

Another statement in this specification is of more importance. It is this: "I am aware that it is not new to construct a feeding mechanism of two series of intermeshing gear wheels, the wheels of one series fixed to their shaft, and the wheels of the other series revolving loosely upon, but capable of being individually keyed to their shaft."

Fig. 1 is a front elevation and Fig. 2 is an end elevation of this device, while Fig. 3 is a longitudinal section of the arrangement for operating the locking keys. In

this part of the device the sleeve v may be moved in or out so as to bring the key x into engagement with any one of the series of gears. When in the proper place the key x is forced in or out by the rod o, in which is fixed the pin q, operating in an inclined slot for that purpose. The sleeve v is held in any desired position by means of the

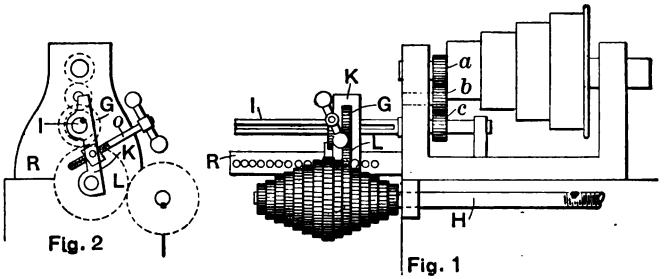


Charles W. Riley. No. 233,702, Oct. 26, 1880.

sliding arm H, traveling upon the square bar M, to which it may be fixed by the pin t, fitting into one of a series of holes in the bar M. The device at C is of the same construction and operation.

Motion is transmitted from the gear a, on the head spindle A, through the gear c, the cones of gears on shafts C and E to the gear e, thence through the gear d to the connecting cones of gears on the shaft D, to that on the

lead screw *B*. While this device would no doubt accomplish what it was designed for, it seems much too complicated for convenient use or long wearing qualities.



Andrew Hyde. No. 247,764, Oct. 4, 1881.

The patent of Andrew Hyde, of Hatfield, Mass., which was granted October 4, 1881, and is numbered 247,764, appears to be in the nature of a combination of the ideas of Humphreys as to the "traveler" with its sliding pinion and that of Miles, with his cone of gears, placed closely in contact with each other. In fact the sliding pinion arrangement is the same as that adopted by Miles except that his method of locking it is different.

The driving is effected through a stud or head shaft connected by gears within the head as some lathes are now constructed. There is nothing really new about it except the method of locking the sliding pinion bracket. His idea of arranging the set of gears in the form of a double cone, with such gears as cut even pitch threads on one end and those which cut odd pitches on the other, could hardly be classed as an invention. The result did not mark any distinct step in advance.

Fig. 1 is a front elevation and Fig. 2 is an end eleva-

tion of this device. The sliding frame or traveler *K*, carries the gears *G* and *L*, journalled in it, the former splined upon the head shaft *I*. By this means the motion is communicated from the head gears *a, b, c,* to any one of the gears of the double cone, and held in position by the clamping screw *o*, whose lower end rests in one of the recesses in the bar *R*.

One difficulty of this arrangement would be the crowding together of the gears when the lathe was running one way and the strain to force them apart when its motion was reversed. Probably the noise produced by such an arrangement of gears would be anything but pleasant. The long overhang of this double cone of gears would be very objectionable.

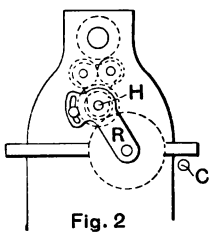


Fig. 2

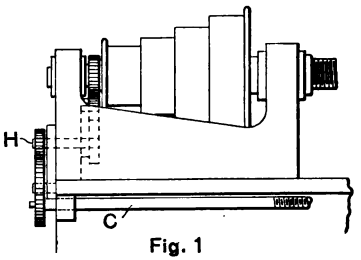


Fig. 1

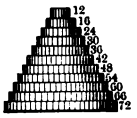


Fig. 3

George A. Gray, Jr. No. 252,760, Ian. 24, 1882.

Patent No. 252,760, dated January 24, 1882, and issued to George A. Gray, Jr., of Covington, Ky., relates to the method of arranging the usual change gears, in which the stud plate is pivoted upon the stud or head shaft and carries always the same idle gears.

Joseph Flather.

The lead screw having a four-pitch thread and the change gears varying by six teeth each from 12 to 72, and the stud gear having 24 teeth, made a convenient arrangement; and changes were made by removing one gear only and replacing it by another, the stud plate being adjusted accordingly. This saved the changing of the idle gear, and cut threads from two to twelve per inch.

In the drawings, Fig. 1 is a front elevation, and Fig. 2 is an end elevation of the device, while Fig. 3 shows the stack of change gears which were used upon the lead screw *C* only. The arrangement of the stud plate *R*, journalled upon the head shaft and held at any desired point by a clamping bolt, is in the ordinary manner.

While the inventor did not avoid taking off a gear and substituting another for each different pitch, it was probably a more satisfactory and practical arrangement than some of the more complicated and pretentious devices, and no doubt served a good and useful purpose.

The ear marks of a practical mechanic are quite visible in Patent No. 462,481, granted November 3, 1891, to Joseph Flather, of Nashua, N. H. In this case instead of one fixed feed gear on the main spindle of the lathe, three or more gears of varying sizes are fixed thereon.

On the head shaft or stud are the same number, and of corresponding sizes loosely fitted and adopted to be engaged individually by means of a sliding rod and pin, the stud being made tubular for that purpose.

A simple and effective arrangement of driving the feed rod is provided, which does not affect the subject herein discussed.

In the drawings, Fig. 1 shows a front elevation of the invention, and Fig. 2 is a longitudinal section through the cone of gears on the head shaft.

A practical device.

Upon the head shaft or stud *a* and upon the lower lead screw *L* are fixed and operated change gears in the usual manner, except that the value of each change gear in screw cutting is multiplied by the number of feed gears on the head spindle. So that while Riley, for instance, used twenty-four gears to cut fifteen threads, Flather needs but eleven, or less than half the number. The gears *d, e, f*, on the head shaft are arranged as shown in Fig. 2.

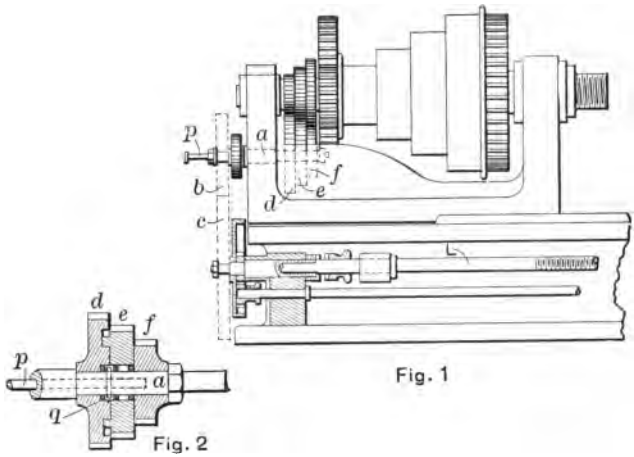


Fig. 1

Fig. 2

Joseph Flather. No. 462,481, Nov. 3, 1891.

The center of gear *e*, being of necessity bored entirely through at an enlarged diameter to accommodate the sliding pin device, is held in position concentrically by a projecting ring formed upon it and fitting into a suitable annular recess in the gear *d*. The gear *f* has a clutch member extending into the gear *e*. The operating rod, *p*, carries a pin, *q*. which engages the clutch member of either of the three gears, as desired.

Peter and William Shellenback.

On February 2, 1892, Peter and William Shellenback, of Richmond, Ind., were granted Patent No. 468,183, These inventors fix a cone of gears on a sleeve splined and sliding upon a driving shaft located within the bed, and moved to any position desired by a pinion whose teeth engage with a series of grooves turned in a projecting end of the sleeve, forming in effect a rack. This pinion is fixed upon a shaft projecting out at the front of the head, where it is controlled and held in position by a lever provided with a spring pin adapted to enter any one of the holes in a fixed segment.

Journalled upon an intermediate shaft located in the head above the driving shaft are the usual driving pinion and an intermediate pinion journalled on a swinging arm operated and held in position by a shaft and pinion engaging teeth cut on a segmental portion of it. This pinion is fixed upon a shaft which projects outside of the end of the bed, where it is operated and held in position by a lever swinging over a segment and provided with a spring pin which enters any one of a series of holes in the segment.

The peculiarity of this arrangement is that instead of the usual "traveler" with its two pinions for connecting the shaft upon which it slides to any one of the series comprising the cone of gears, the cone of gears itself slides bodily to any one of the required positions.

Among other things the inventor says: "In many kinds of work it is desirable that the carriage should move in one direction while the tool is cutting, and when the tool is withdrawn from the work it should return to the starting point to enable the tool to make a fresh cut." Perhaps we ought to be grateful for this information.

In the drawings, Fig. 1 is a front elevation showing the bed and a portion of the head in vertical section, and

Fig. 2 is an end elevation. Power for driving the lead screw is transmitted from the head spindle through the gears *a, b,* to a fixed stud *c,* having journalled upon it the two gears *d, e,* which are fixed to each other and mesh into two pinions on a supplementary shaft *h,* to which either may be connected by a sliding key operated by the rod *k*.

Upon the shaft *h* is fixed the toothed segment *l*, which is operated by the shaft *m*, having the pinion *n* formed upon it. Fixed also to the shaft *h* is the arm *o*, having

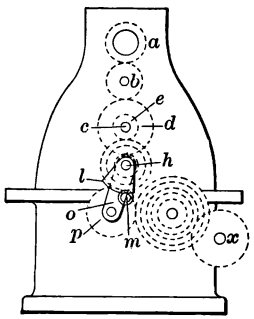


Fig. 2

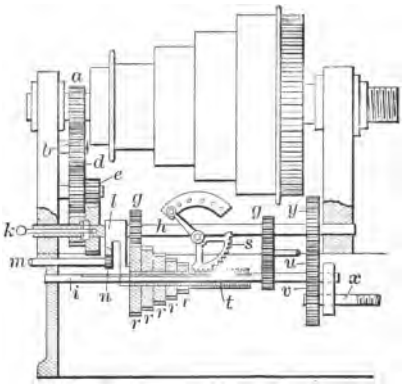


Fig. 1

Peter and William Shellenback. No. 468,183, Feb. 2, 1892.

journalled to a stud fixed in it the connecting gear *p*. This is continually in mesh with the gear *g*, fixed to the shaft *h*, and capable of being brought into engagement with any one of the cone of gears fixed upon a sleeve splined to the shaft *i*, as they are brought opposite to it by the action of the toothed segment *s*, engaging in the grooves of the sleeve *t*, to which the gears *r, r, r, r*, are fixed.

Motion is communicated from the shaft *i*, through

the gears *u*, and *v*, to the lead screw *x*. Motion may also be communicated by way of the gear *g*, without bringing the cone of gears into use.

We now come to a patent which has probably caused more interest and discussion on this subject than any one previous to its issue. It is No. 470,591, and was issued March 8, 1892, to Wendel P. Norton, then of Mount Vernon, N. Y., but later of Torrington, Conn. It contains some of the good ideas of the earlier inventors, now brought into good mechanical form and combination for producing practical results.

Humphreys in 1868 introduced the cone of gears. They are here. He wrote: "I place my gear wheels upon a shaft *A*, ranging from the smallest to the largest." Norton says: "On the shaft *A*, and within the box *B*, are secured a series of gear wheels *E*, of varying diameters, arranged step-like," etc. Humphreys placed his gears a little more than the width of the face apart. Norton places his close together, like Miles in 1871 and Hyde in 1881.

The clumsy arrangement of Humphreys' "traveler," Miles' "moving swinging arm" and his "shifting clamp," and Hyde's "sliding frame," is replaced by a compact and well-arranged sliding, forked lever, carrying the connecting pinion.

Altogether it is a good example of how the crude efforts of the early inventors may be, by the present advanced state of mechanical knowledge, put into practical and useful combination.

In the drawings, Fig. 1 is a front, and Fig. 2 is an end elevation of this device. Motion is communicated from the head spindle by way of the usual head shaft and the gears *a*, *b*, *c*, to the supplementary shaft *H*, upon

which is fitted the sliding arm *G*, the latter carrying a gear splined to the shaft *H*, and also the connecting pinion *F*, journalled in it, and capable of connecting with either of the gears *E*, *E*, *E*, etc., on the shaft *A*.

This sliding lever *G*, is conveniently arranged with a handle, and a thumb-lever *K*, having formed upon it a pin entering any one of the holes in a fixed plate *J*, its position first being readily located by a series of notches in the lower edge of the plate into which a portion of the lever *G*, enters. The pin on the lever *K*, finally secures it accurately in place.

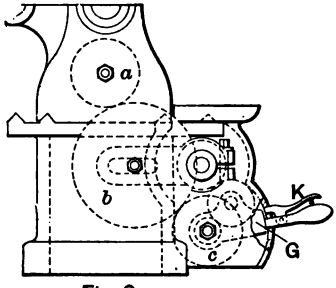


Fig. 2

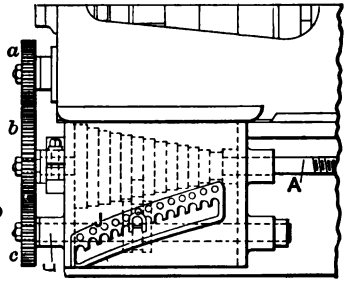


Fig. 1

Wendel P. Norton. No. 470,591, March 8, 1892.

The device has been for several years in practical use in many shops in this country.

There is nothing especially noticeable in the effort of William Shellenback, of Richmond, Ind., who on April 10, 1894, obtained Patent No. 518,164, for his device, in which he placed a cone of gears on a shaft within the bed and applied the much-used traveling pinion to connect its different gears with the driving shaft above it.

In the drawing, Fig. 1 is a side elevation, and Fig. 2 is an end elevation of the device. A yoke plate *e*, carries a

stud upon which are journalled the flanged gears *c, d,* which may thus be brought into action by sliding them upon the stud, their flanges retaining them in place. By this means a second series of speeds produced by the cone of gears is obtained.

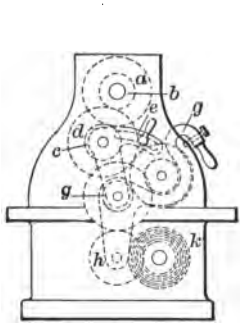


Fig. 2

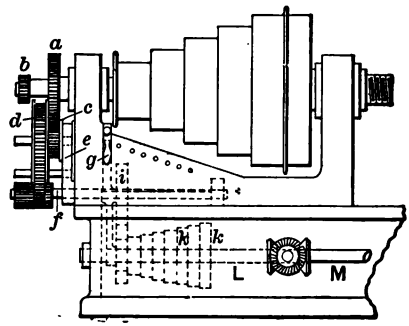


Fig. 1

William Shel enback. No. 518,164, April 10, 1894.

The shifting lever *g,* is journalled upon the supplementary shaft *f,* and has journalled upon a stud fixed in its lower end the connecting gear *h,* by which the gear *i,* on the supplementary shaft *f,* is connected at will with any one of the gears *k, k,* etc., of the cone of gears splined to the supplementary shaft *L,* which is connected with the lead screw *M,* by a short transverse shaft extending through the front of the bed and operated by miter gears.

While the space within the bed affords plenty of room in which to place any number of gears and their necessary appendages, and while they are out of the way more than if placed in front of the bed, the device has the disadvantage of being difficult to get at in case of accident, and until we can do much better in our designs and workmanship, and have a higher grade of operatives to

attend them, accidents will sometimes occur to the best constructed machinery.

The second patent of Wendel P. Norton, viz., No. 519,924, granted May 15, 1894, was not properly for change gears, but intimately connected with them, inasmuch as it was for a compact and well-devised method of reversing the motion of the change gears by means of three miter gears located within the lathe head and conveniently operated by proper levers and a reversing rod worked from the lathe apron, thus forming an automatic stop.

In the drawings, Fig. 1 is a front, and Fig. 2 an end elevation, a portion of the head being shown in vertical section in Fig. 1 for the purpose of more clearly showing the reversing device. Power to operate the lead screw

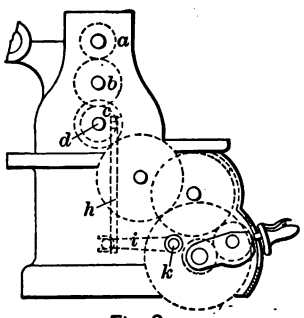


Fig. 2

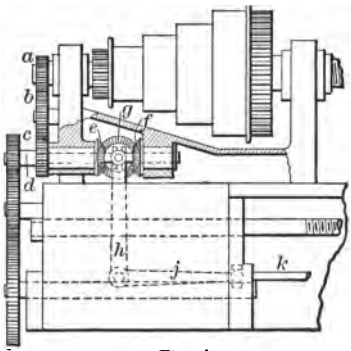


Fig. 1

Wendel P. Norton. No. 519,924, May 15, 1894.

through the medium of the device shown in Patent No. 470,591, is transmitted from the head spindle through the gears *a*, *b*, *c*, to the head shaft *d*, which has loosely journalled upon it the miter gears *e* and *f*.

Both of these gears are in mesh with a third miter

gear *g*, located in their rear and journalled upon a fixed stud. Between the miter gears *e* and *f*, there is a clutch splined upon the head shaft *a*, Fig. 2, with clutch members formed on each face and adapted to be engaged with similar clutch members formed on either of the miter gears *e* and *f*. This clutch is operated by the levers *h*, *i*, *j*, and the tumbling rod *k*.

This device is really a continuation, or rather perhaps the completion of the device shown in the former Norton Patent No. 470,591, so that he accomplishes not only a great number of changes, but also reverses them at will or automatically.

The Patent No. 525,863, granted September 11, 1894, to Salmon W. Putnam, of Nashua, N. H., in so far as it related to cutting threads was for the purpose of cutting either the English or the metric standard threads without removing a change gear.

It is represented in the drawings, Fig. 1 showing front, Fig. 2, an end elevation, and Fig. 3, the shifting lever by which the lathe is adjusted for English or metric threads or for a belt feed.

The device consists of a lead screw in two parts, *A* and *B*, which may be connected by a clutch *C*, the toothed part of which is splined on that portion of the screw projecting through the head of the lathe and the other part formed upon the gear *D*, fixed on the portion of the lead screws threaded in the usual manner.

Both the gears, *E* and *D*, engage a double gear *H*, splined on a short feed rod *F* (not extending to the apron). Fixed on the feed rod *F*, is one portion of a clutch *G*, formed upon the double gear *H*, having the gear *L*, formed upon it, the other portion being formed upon the bracket *J*, in which the rod *F* is journalled.

The usual feed cone is also fixed upon the feed rod. These clutches were operated simultaneously by a lever *K*, which, standing in the position shown, enabled the lathe to cut metric threads. With the upper clutch *C* closed, English threads were cut. With the lower clutch *G* closed the usual belt feed was obtained, through the lead screw, upon which a sliding bevel pinion (not shown), operated the apron feed.

The device is a compact arrangement for accomplish-

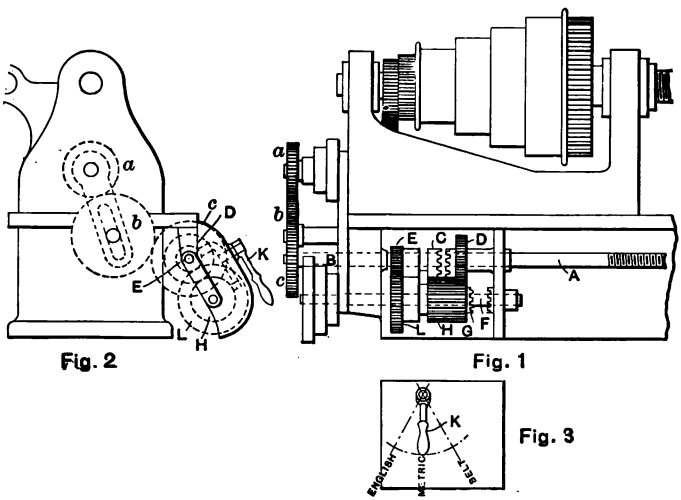


Fig. 2 Fig. 1 Fig. 3

Salmon W. Putnam. No. 625,863, September 11, 1894.

ing the main object sought, that is, to readily change the lathe from English to metric threads and again to belt feed; but whether it would be of such frequent use in the average machine shop as to make its adoption general is somewhat doubtful.

It should be said that the regular change gears were

applied in the usual way, the device being adapted particularly for the different systems of threads. The lead screw also operated the feed rod.

The first attempt at mounting all the change gears upon a circular plate which might be rotated to successively bring each of the gears into action, is described in Patent No. 536,615, granted to Edward Flather, of Bridgeport, Conn., April 2, 1895.

This system requires considerable room at the head of the lathe and thirty-three gears of various sizes, with

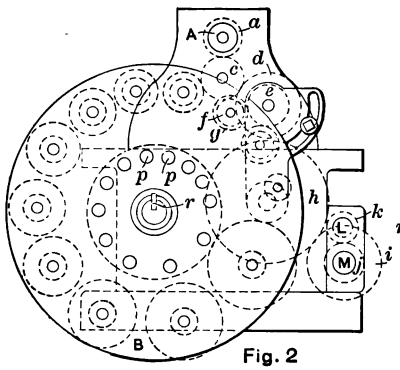


Fig. 2

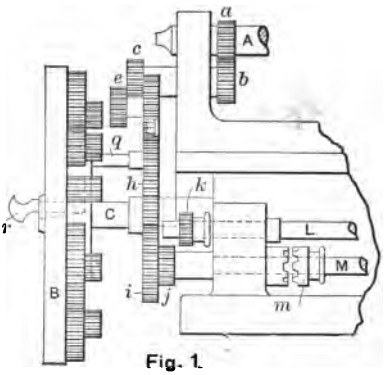


Fig. 1

Edward Flather. No. 536,615, April 2, 1895.

proper studs, swing plate, fastenings, etc., to cut only twelve different pitches of thread.

An arrangement of clutches makes this system of gears also available for driving the feed rod.

The inventor mentions some modifications of this plan, which do not seem important and do not materially reduce its large number of gears and other parts.

In the drawings, Fig. 1 is a front elevation and Fig. 2 is an end elevation of the invention. From the head

spindle *A*, the power is carried through the gears *a*, and *b*, to the gear *c*, which will engage in turn with any one of the smaller of the pair of gears journalled upon the revolving plate *B*, while the gear *e*, is likewise adapted to engage at the same time any one of the larger of the pairs of gears journalled on the plate *B*. This provides for the change from one pitch to the other, the motion being continued through the gears *h*, *i*, *j*, and *k*, the latter fixed to the lead screw *L*.

The revolving plate *B*, is arranged to slide out upon its spindle *C*. This enables the operator to revolve it to any desired position to bring the proper gears into engagement with the driving and transmitting gears, the series of pairs of gears carried by the plate being loose upon their studs and serving as compounding gears of varying ratios when brought into action.

The revolving plate is provided with a series of holes *p*, located at proper intervals and engaging the fixed stud *q*, when the plate is forced back to its operative position after being brought to its proper place. It is prevented from working out of place by the spring catch *r*. The gear *k*, is splined to the lead screw *L*, and may be withdrawn from engagement with the gear *j*, when it is desired to drive the feed rod *M*, which is engaged by closing the clutch *m*.

Benjamin F. Burdick obtained on April 23, 1895, Patent No. 537,816, in which he introduces a double disk of gears, which are brought into action with the driving gear and the lead screw respectively by pivoting the gear disks or cases eccentrically upon a central shaft.

The idea is ingenious and effective, probably as much so as is possible with the arrangements known as the "disk of gears."

In the drawing, Fig. 1 is a face view or what would be, when it is applied to a lathe an end elevation. Fig. 2 is a vertical section, showing the eccentric location of the disks. The case *A*, is recessed on each side, the centers of each recess being eccentric with the other.

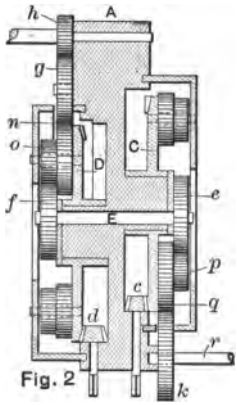


Fig. 2

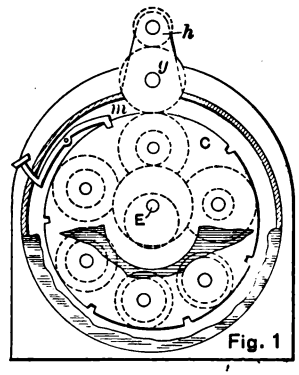


Fig. 1

Benj. F. Burdick. No. 537,816, April 23, 1895.

Upon the hubs formed in making these recesses are journalled two gear-carrying plates *C*, *D*, having bevel gear teeth formed upon them, which are engaged by the bevel pinions *c*, *d*, by which they are rotated to any desired positions. Through the center of this case is the transmitting shaft *E*, having fixed upon it the gears *e*, *f*. Each of the revolving disk carries, journalled upon fixed studs, a series of pairs of gears of unequal diameters, fixed together, and capable of being brought into engagement with the transmitting gears *g*, *h*, on the one side and the transmitting gear *k*, on the other, the eccentricity of the centers of rotation being exactly sufficient to do this.

Each of the gear disks is held at any desired point

by lever *m*, engaging suitable slots in the edge of the disk. Thus, for instance, the motion is conveyed from the lathe by the gears *h*, and *g*, through the gears *n*, *o*, *f*, the shaft *E*, the gears *e*, *p*, *q*, and *k*, to the shaft *r*, and thence to the lead screw.

By providing two disks of gears the number of changes is multiplied without the same addition of gears which would be required in the device of Edward Flather, last considered. If the disk of gears is to be used at all, the method of locating one or more of them, as desired, in an eccentric position relatively to the engaging gears, so as to conveniently bring either pair of gears into action without the use of catches, sliding movements and similar devices, would seem to be the best method.

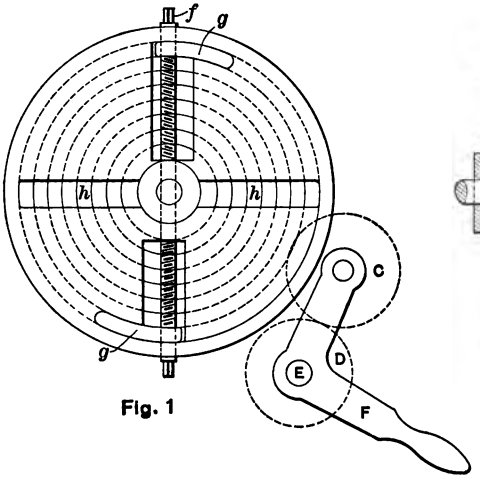


Fig. 1

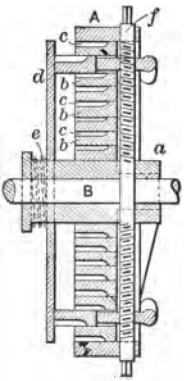


Fig. 2

Carl J. Paulson. No. 541,385, une 18, 1895.

It remained for Carl Johan Paulson, a Swede, of Brooklyn, N. Y., to invent an entirely new application of

the principle of the cone of gears and traveling pinion, or at least an ingenious modification of it, which is shown in his Patent No. 541,385, dated June 18, 1895.

In place of having a series of different sized gears side by side, he places them one within the other in the form of a series of rings, capable of being individually moved out of position of action, where the teeth cut upon the ring are engaged by a pinion journalled on a swinging arm in the usual manner.

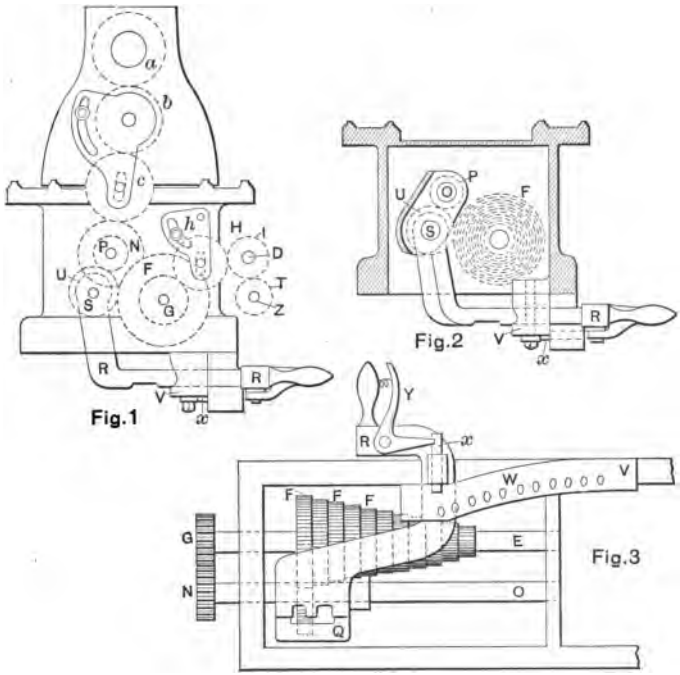
In the drawings, Fig. 1 shows a face view of his device, and Fig. 2, a vertical section. In a circular case *A*, provided with a central hub *a*, is arranged a series of rings *b*, *b*, *b*, etc., completely filling the annular space. These rings have spur gear teeth cut upon them as shown at *c*, *c*, *c*, etc. They are prevented from becoming detached by the retaining plate *d*, which, in turn is held in place by the spring *e*. The screw *f*, has cut upon it right and left-hand threads, upon which are fitted cams *g*, *g*, whose office it is to project the required ring as the cams are brought opposite to it by revolving the screw *f*.

The central shaft *B*, is the driving shaft of the device and from either ring gear employed the power is transmitted by the gears *C*, and *D*, journalled on the swinging lever *F*, or vice versa, as may be desired. Each of the ring gears have lugs *h*, *h*, etc., formed upon them by which the whole device is revolved.

On November 2, 1897, Herbert L. Flather, of Nashua, N. H., was granted Patent No. 592,966, in which he makes use of the cone of gears fixed upon a supplementary shaft located in the lathe bed. The secondary shaft is parallel to it and has upon it the usual traveler carrying its pinion splined to the shaft, and the intermediate, or traveler pinion journalled on it. The lever by

which the traveler is operated and fixed in position is an ingenious device and quite different from Norton's.

The cone of gears arrangement is to be operated in connection with interchangeable gearing, much the same as the usual change gears, so that the older method of taking off and putting on gears was not wholly eliminated.



Herbert L. Flather. No. 592,966, November 2, 1897.

In the drawing, Fig. 1 is an end elevation of the device; Fig. 2, is a transverse section of the bed, showing the cone of gears; and Fig. 3 is an inverted plan showing the cone of gears, shifting lever and their appendages.

The power is transmitted from the head spindle through the gears *a, b, c,* to the gear *N,* on the transverse shaft *o,* upon which is journalled the shifting lever *R,* carrying the connecting gear *U,* journalled on the stud *S.* Upon the shaft *E* is fixed the cone of gears *F, F, F,* etc. (The shafts *E* and *O* are not connected by the gears *G,* and *N,* as would appear in Fig. 3, one of these shafts being considerably lower than the other, as will be seen in Fig. 1). The shifting lever *R,* is controlled in its movements by the guide plate *V,* and held at any desired point by the pin *x,* (actuated by the thumb lever *Y,*) entering the proper hole *w,* in the guide plate *V.*

The power is carried on from the cone of gears, through the gears *G, H,* and *I,* to the lead screw *D,* and by the gear *T,* to the feed rod *Z.* The gears *G, H,* and *I,* are adapted to be changed in the usual manner whenever desired.

Patent No. 595,562, granted December 14, 1897, to Ernest J. Flather, of Nashua, N. H., is somewhat in the nature of a combination of Patents No. 470,591 and No. 519,924, granted to Wendel P. Norton, improved in the general arrangement and with some good points added.

In this case the cone of gears, which by this time seems to have become very popular with inventors, is placed upon a short shaft in front of the bed and arranged to drive either the lead screw or the feed rod.

In addition to this, the bevel reversing gears of Norton's patent, No. 519,924, are placed on the line of this shaft, to the left of the cone of gears, (and not shown in the drawing) which would seem to be a preferable position. The method of handling the traveling intermediate gear is ingenious and practical.

In the drawing, Fig. 1, is a front elevation; Fig. 2, is

a transverse section of the cone of gears and appendages; Fig. 3, is a section through the shifting lever and its connecting parts, and Fig. 4, is a perspective view of the same, showing its eccentric pivoting trunnions.

The power for driving the lead screw is transmitted from the head spindle through the gears *a, b, c, d,* and *e,* in the usual manner, to the supplementary shaft *D,* upon which the shifting lever frame *K,* is journalled. Within

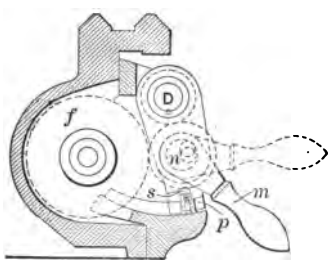


Fig. 2

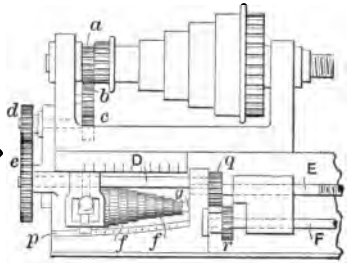


Fig. 1

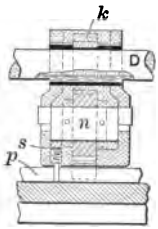


Fig. 3

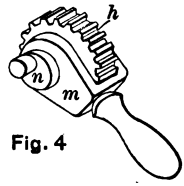


Fig. 4

Ernest J. Flather. No. 595,562, December 14, 1897.

this case is fitted the shifting lever *m,* carrying the connecting gear *h,* meshing into the shifting pinion *k,* on the shaft *D.* The shifting lever *m,* is pivoted upon an eccentric shaft *n,* by which it is brought into position as desired, and is readily dropped out of engaging position when it is desired to shift to any other position.

Its position in shifting is guided by the guide *p*, properly perforated for the spring pin *S*. Upon the right-hand end of the shaft *g*, is a gear, (not shown), meshing with the gear *q*, on the lead screw *E*, and driving it. Upon the feed rod *F*, is splined a gear *r*, which may be moved into engagement with the gear *q*, and thus power is transmitted to the feed rod.

Benjamin A. Wheeler patented, April 26, 1898, (No. 602,924), a lathe in which he placed the cone of gears in the apron instead of in or near the head, connecting it with the lead screw by a clutch, which is closed by the lever operating the lead screw nut.

Two cones of gears, on which the changes are made by a sliding key, are placed at the end of the bed. The serious objection to the placing of the gears in the apron seems to be an undue loading down of the apron and carriage, as well as very much complicating these parts without a corresponding increase of efficiency.

The inventor's reason for the innovation is the elimination of torsional strain in the lead screw, which is much more economically attained by enlarging the lead screw to a proper diameter.

In the drawings, Fig. 1 is a side elevation; Fig. 2 is an end elevation; Fig. 3 is a longitudinal section through the cone of gears in the apron, and Fig. 4 shows a cross section of the shifting lever.

Power is transmitted in the usual manner from the head spindle, through the gears *a*, *b*, *c*, *d* and *e*, to the first cone of gears *f*, all of which engage the opposite gear of the cone of gears *g*, on the shaft *h*. Either of the gears of the cone *g*, may be brought into action by a sliding key operated by the knob *i*, thus making five changes of

speed. Upon a sleeve mounted on the lead screw *E*, are ten gears *j, j, j,* etc., forming the cone of gears.

Upon the hub of the largest gear is formed a clutch member adapted to be engaged by a similar clutch member formed upon the sliding clutch *k*, upon which are also formed rack teeth *l*, engaging similar teeth on two bell-crank levers *m, m,* which are operated by

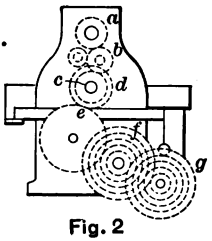


Fig. 2

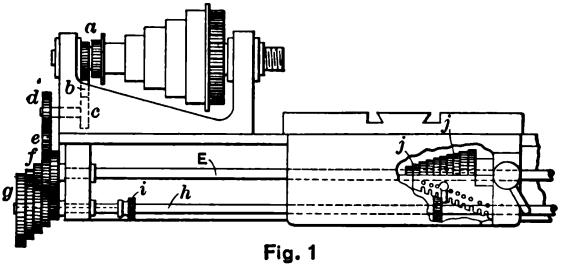


Fig. 1

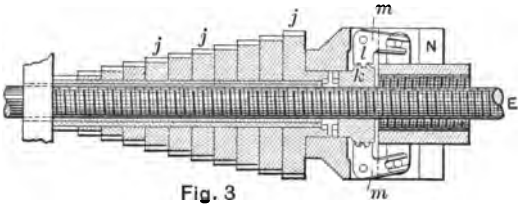


Fig. 3

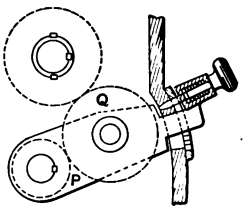


Fig. 4

Benj. A. Wheeler. No. 602,924, April 26, 1898.

pins fixed on the two parts of the lead screw nut *N*. The shifting lever *P*, carrying the connecting gear *Q*, is arranged and operates in the usual manner, as shown in Figs. 1 and 4.

On December 5, 1899, William L. Shellenback, of Philadelphia, Penn., obtained Patent No. 638,359, in

which he followed Edward Flather, 1895, and Burdick, 1895, in the arrangement of a disk of gears in which he simplified the device of Flather, but hardly equalled the ingenuity or efficiency of that of Burdick.

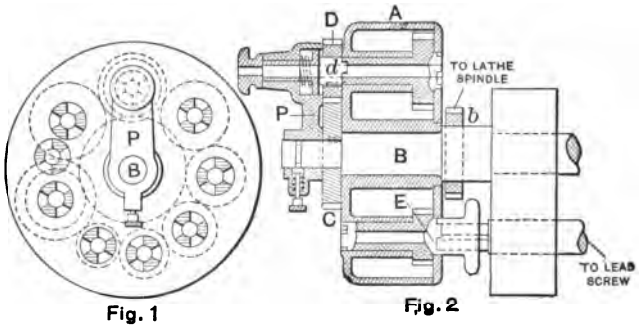


Fig. 1 Fig. 2

William L. Shellenback. No. 638,359, December 5, 1899.

In the drawings, Fig. 1 is a face view of the device, and Fig. 2 is a vertical section on the center line. A circular case *A*, contains the gearing, and is journalled on a main shaft, *B*, which is fixed to and derives its power from the head spindle through gear *b*. The main shaft has fixed to it driving gear *C*, engaging with the pinion *D*, fixed to a short spindle *d*, journalled in the rotating arm *P*.

Arranged around the gear case *A*, is a series of gears, all engaging each other, as shown by the heavy dotted circles in Fig. 1, and provided with clutch members to be engaged as required, by the spindle *d*, of the rotating arm *P*, to transmit motion to the train, and by a similar clutch at *E*, to convey the power at varying speeds to the lead screw. By withdrawing the clutch *d* from engagement the rotating arm *P* may be carried

around to a proper position to bring into action any gear of the series.

William L. Shellenback, in Patent No. 667,406, dated February 5, 1901, revised his device shown in Patent No. 638,359, making it a double disk of gears, and mounting them eccentrically after the manner shown by Burdick in 1895.

In the drawing, Fig. 1 is a face view of the device; Fig. 2 is a vertical section, and Fig. 3 is an elevation of the reversing device. The device is supported upon an attaching plate *A*, which has formed upon it a sleeve,

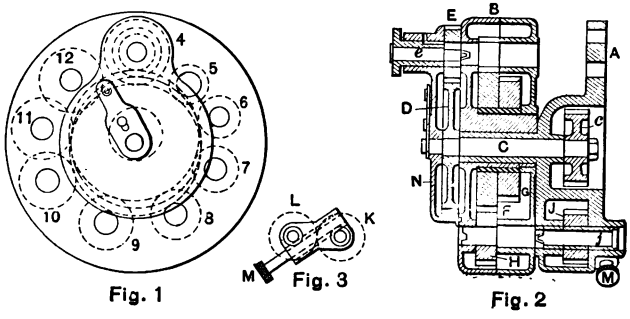


Fig. 1 Fig. 3 Fig. 2

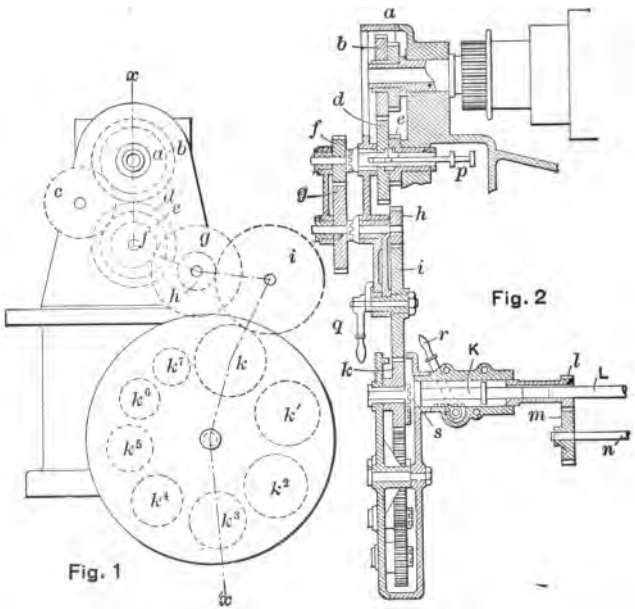
William L. Shellenback. No. 667,406, February 5, 1901.

upon which the gear case *B*, is journalled. Through this case passes the main shaft *C*, having fixed upon it the gear *c*, which receives the driving power from the lathe.

Upon the opposite end of the shaft *C*, is fixed the main driving gear *D*, engaging the gear *E*, in the rotating housing. Upon the hub of the gear case *B*, are journalled the gears *F*, and *G*, fixed to each other, the gear *F*, being adapted to mesh with the gears 4, 6, 7, 8, 9, and 11, of the front portion of the gear case, and the gear *G*, to

mesh with the gears 5, 10, and 12, located in the rear portion of the gear casing, (not shown in Fig. 2).

The gear casing *B*, being journalled eccentrically on the supporting sleeve, it follows that only the gears brought into engagement by arriving at the proper side of this eccentric movement will be in action. Each of the series of gears, 4, 5, 6, 7, 8, 9, 10, 11, and 12, are fixed



Edward A. Muller. No. 679,568, July 30, 1901.

upon shafts having clutch members formed upon both ends so as to engage with the clutch member on the end of the spindle *e*, of the secondary case *N*, on the one side, and with the clutch member on the spindle *j*, of the gear *J*, on the other. By thus providing for the revolution of

the main gear case *B*, and the secondary gear case *N*, a large number of changes are possible.

The device shown in Fig. 3, has two pinions cut on the shaft of the knurled head *M*, by which the spindles of the gears *L*, and *K*, may be moved, one into engagement and the other out, and *vice versa*, for the purpose of reversing the direction of the feed mechanism.

In Patent No. 679,568, granted July 30, 1901, to Edward A. Muller, of Springfield, Ohio, we find a combination of clutches, sliding splines, swinging stud plates, rack and pinion, gears mounted on disks, gears journalled in casings, gears on the head spindle, gears on primary shafts, gears on secondary shafts, gears on supplementary shafts, in delightful profusion to the student, but we fear in confusion to the every-day mechanic.

In the drawing, Fig. 1 is a face view of the invention, and Fig. 2 is a sectional development of the train of gearing on the dotted line *x*, *x*, Fig. 1. The direction of the transmission of power is readily seen in Fig. 1, from the gear *a*, through *c*, to *e*, directly from *b*, to *d*, thence by the gear *f* to *g* and from *h* to *i* from which to any one of the series of eight gears marked, *k*, k^1, k^2, etc., to the shaft *K*, and the lead screw *L*. From the lead screw the gears *l*, and *m*, drive the feed rod *n*. The gears *d*, and *e*, may either be brought into action by the rod *p*, operating the sliding key as shown in Fig. 2.

The gears *f*, and *g*, are arranged with clutches as shown in Fig. 2, so that they and the connecting case in which they are journalled may be removed and another case of a different ratio of gears substituted, whereby the changes made possible by the gears *a*, *b*, *c*, *d*, and *e*, may be further increased. The gear *i*, is journalled upon a swinging arm clamped in position by the lever *q*, as

may be necessary to bring the gear into engagement with any one of the series k, k^1, k^2, k^3, etc., as the gear case containing them is rotated.

When the proper gear of the series is in position the shaft K, is brought into position to engage the clutch s, by means of the lever r. The shaft K, is splined to the

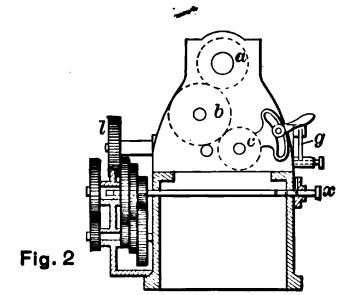


Fig. 2

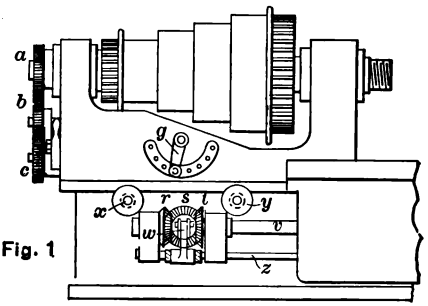


Fig. 1

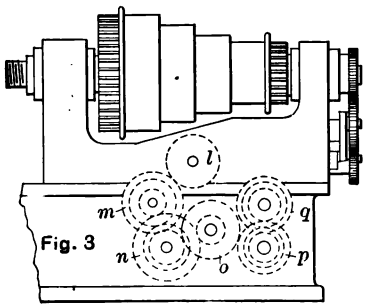


Fig. 3

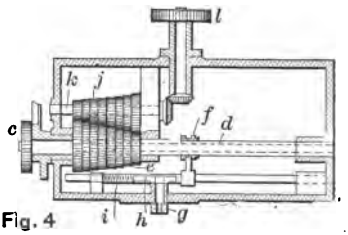


Fig. 4

Herman R. Isler. No. 684,432, October 15, 1901.

sleeve on which the gear l, is formed. The lead screw L, is also splined to it and is thus driven with it.

Herman R. Isler, in his Patent No. 684,432, dated October 15, 1901, seems to have had great faith in the efficiency of the much used cone of gears, and may have thought that if they were good things, the more he had

the better, for he not only places two cones of gears in the bed, but mounts four more cones of gears, together with various connecting gears at the back of the head on shafts journalled in the bed.

These are all operated by sliding keys, while racks, segments, and bevel gears are introduced with a lavish hand. The arrangement doubtless proved rather expensive as well as unnecessarily complicated.

It would not probably be too much to say that he was well acquainted with Norton's reversing bevel gears.

In the drawing, Fig. 1 is a front elevation; Fig. 2 is an end elevation, showing the bed and a portion of the rear gear casings in section; Fig. 3 is a rear elevation, and Fig. 4 is a horizontal section through a portion of the head. The power is taken in the usual manner through the gears *a, b, c,* to the shaft *d,* upon which one cone of gears *e,* is journalled.

Any one of these gears is brought into action by a sliding key operated by the clutch sleeve *f,* controlled by the lever *g,* through the medium of the segment *h,* and rack *i.* The gears of the cone *e,* engage those of the cone of gears *j,* fixed upon the shaft *k,* from which miter gears connect to the gear *l,* and thence to the series of gears at the back shown in Figs. 2 and 3. The motion here passes through the gears *m, n, o, p* and *q,* and thence to the reversing bevel gears *r, s, t,* to the lead screw *V.*

The cone of gears *n,* and *p,* are fixed to their shafts, while those of the cone of gears *m,* and *q,* are controlled by sliding keys operated by the knobs *x,* and *y.* The reversing clutch *w* is operated by a quick-threaded worm on the reversing rod *z,* whose rotation is controlled at the apron.

Again in Patent No. 684,433, also dated October 15,

Another Isler device.

1901, Herman R. Isler tries his hand at the change gear problem, this time adapting the plan of a disk of gears. These two applications for patents followed each other at intervals of about two and a half months.

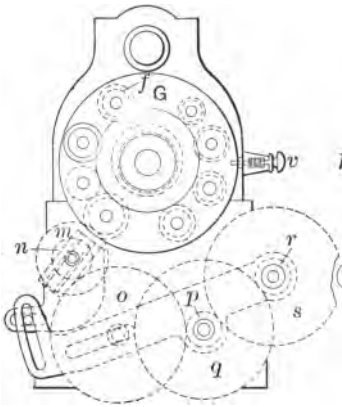


Fig. 1

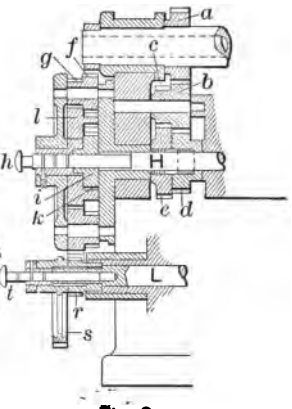


Fig. 2

Herman R. Isler. No. 684,433, October 15, 1901.

This device is much more simple than his former effort and is arranged on the popular eccentric plan first shown by Burdick in 1895. The pinions of the disk of gears are operated by sliding keys.

In the drawing Fig. 1 is an end elevation of the device, and Fig. 2, is a vertical, longitudinal section. Power is transmitted from the head spindle by the gears *a, b, c, d,* and *e,* the latter four being arranged in two pairs, *d,* and *e,* being brought into action by means of a sliding key, operated by the knob *h,* thus giving the shaft *H,* two changes of speed. Gear, *i,* is splined on the shaft *H,* and engages the internal gear *k.*

Formed on the outside of the internal gear *k,* is the

gear *l*, which is adapted to engage a series of gears *f*, *g*, etc., of varying sizes disposed around it as shown in Fig. 1. These gears are in pairs, one of which is adapted to engage the external gear *l*, and the other to engage the idle gear *m*, to which is attached the gear *n*, engaging the gear *o*.

Upon the next stud are the gears *p*, *q*, engaging similar gears *r*, *s*, on the lead screw *L*, the latter being brought into individual action by the sliding key controlled by the knob *t*. The revolving disk *G*, carrying the series of gears *f*, *g*, etc., is held in place in any desired position by the spring pin *v*.

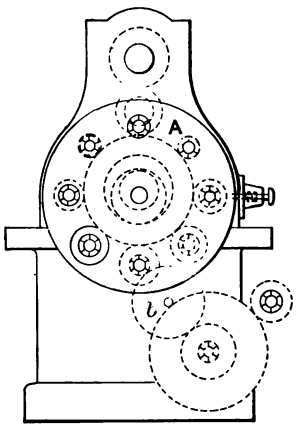


Fig. 1

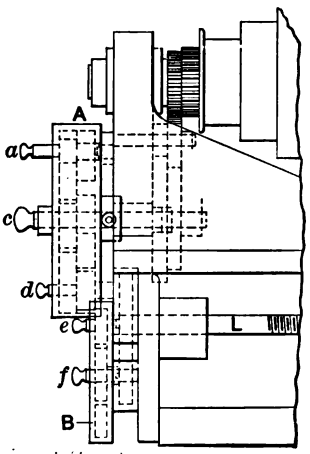


Fig. 2

Herman R. Isler. No. 704,645, July 15, 1902.

Once more Herman R. Isler attempts to solve the change gear idea, in Patent No. 704,645, dated July 15, 1902. He adheres to the "disk of gears" form and improves on his previous device, retaining the eccentric method of mounting and adding a supplementary ar-

rangement for multiplying the speeds obtained by the pinions in the disk.

The former are still controlled by sliding keys. In the drawing, Fig. 1 is an end elevation, and Fig. 2 a front elevation of the device, the series of gears of the disks being represented by dotted circles. Power is conveyed from the head spindle in the same manner as in his last patent, and the gears of the first disk *A*, are arranged in the same manner.

But instead of the final gear driving direct to the lead screw, it conveys motion by means of idle gear, *b*, to a second disk of gears *B*, arranged substantially in the same manner and designed to still further multiply the possible changes of speed at which the lead screw *L*, may be driven. The knobs, *a, c, d, e, f*, are adopted to effect the various changes by throwing into and out of engagement a series of clutches connecting the required gears and disconnecting those not needed.

One disk or case full of revolving gears, most of which would probably be ruined by the breaking of a single tooth in any one of the numerous gears, is bad enough, but when another box of "gear trouble" is added it would look like hunting for difficulties that are apt to come fast enough at best.

Richard K. LeBlond, of Cincinnati, Ohio, shows us in his Patent No. 706,186, dated August 5, 1902, a practical and very mechanical method of obtaining a large variety of feeds and threads pitches by the combination of three cones of small gears, and the necessary sliding gears for connecting either the lead screw or the feed rod, the whole being operated by two handles and a knob.

The arrangement of shafts, gears, and yokes is very compact and is principally within the lathe bed. One

peculiarity of this arrangement is that the yokes or "travelers" carry not only connecting gears but cones of gears. This is also seen in the device of Peter and Wil-

In the drawing, Fig. 1 is an end elevation of the device, and Fig. 2 is a development, in section, of the liam Shellenback in 1892.

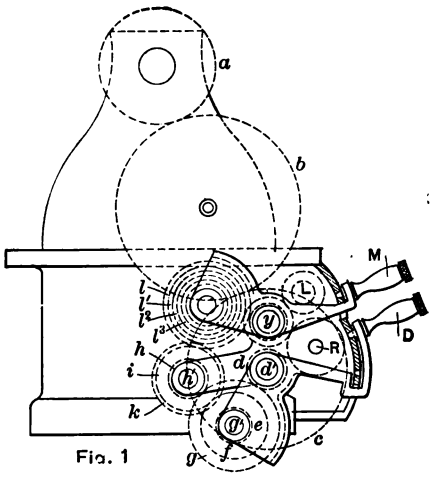


Fig. 1

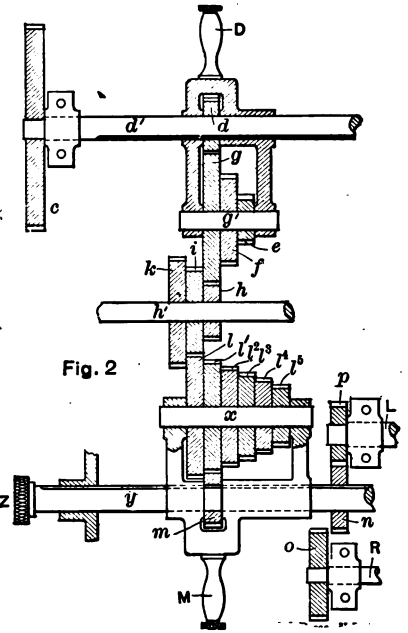


Fig. 2

Richard K. Le Blond. No. 706,186, August 5, 1902.

train of gears from the regular connecting gears from the head spindle to the lead screw and feed rod.

The path of the transmission of power, is from the head spindle gear, *a*, to *b*, and *c*, upon the shaft d^1, on which slides the traveler *D*, carrying the pinion *d*, and in

whose forked end are journalled the gears *e*, *f*, *g*, on the shaft g^1, adapted to engage as desired the gears *h*, *i*, *k*, on the shaft h^1. The gear *i*, engages the gear *l*, of the cone of gears *l*, l^1, l^2, l^3, etc., mounted on the shaft *x*, journalled on the sliding lever *M*, which also carries the connecting pinion *m*.

By proper manipulation of the lever *M*, the gear *l*, may be made to engage either of the gears *h*, *i*, *k*, and also any gear of the cone of gears *l*, l^1, l^2, l^3, etc., may en-

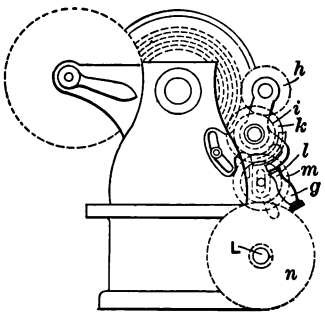


Fig. 1

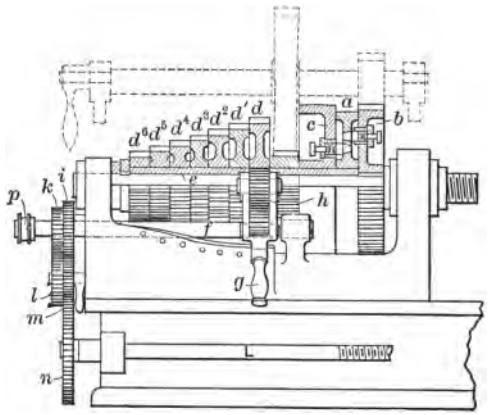


Fig. 2

William T. S. Johnson. No. 706,665, August 12, 1902.

gage the gear *k*, thus producing a large number of changes. Upon the shaft *y*, is fixed the gear *n*, which may by means of the knob *z* be brought into engagement with the gear *p*, on the lead screw *L*, or the gear *o*, on the feed rod *R*. The levers *D*, and *M*, are operated and held in any desired position in the usual manner, as shown in Fig. 1.

It is evident that when William T. S. Johnson, of

Cincinnati, Ohio, set out to devise the arrangement for which he obtained Patent No. 706,665, dated August 12, 1902, he was determined to produce something that would at least be novel, whatever other claim it might have to interest mechanical men.

In this case the oft-recurring cone of gears is placed upon a sleeve journalled directly upon the head spindle of the lathe in place of the usual head cone for driving the lathe, and providing only one large pulley for that purpose. The well-known system of a traveling pinion is used on a supplementary shaft, upon the end of which are placed two gears which, in connection with two others on a stud, form the usual combination for multiplying the changes by two.

In the drawings, Fig. 1 is an end elevation, and Fig. 2 is a front elevation and partial vertical section. The usual back gears are of modified construction as seen in Fig. 2, the face gear *b*, being fixed to the head spindle and the disk *a*, used as a means of connection between it and the single driving pulley *c*, the connection being by spring pins, as shown. The cone of gears, *d*, d^1, d^2, d^3, etc., is mounted and fixed upon a sleeve *e*. Sliding upon the supplementary shaft *f*, is the lever *g*, carrying the connecting pinion *h*, through which power is transmitted to the gears *i*, *k*, and thence to similar intermeshing gears *l*, *m*, to the gear *n*, on the lead screw *L*. Either gear *i* or *k* may be connected to the shaft *f*, as desired, by means of a sliding key operated by the knob *p*.

Thus, while the number of speeds of the head spindle is very much reduced, (unless some form of variable speed countershaft, or an easily controlled electric motor is used), the number of speeds of the lead screw is very easily obtained. Yet the sacrifice of the usual five-step

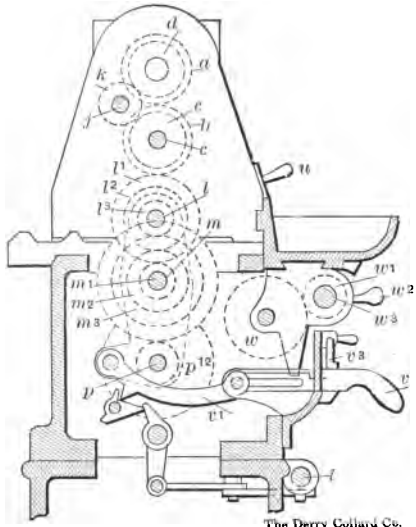


FIGURE 2.

The Derry Collard Co.

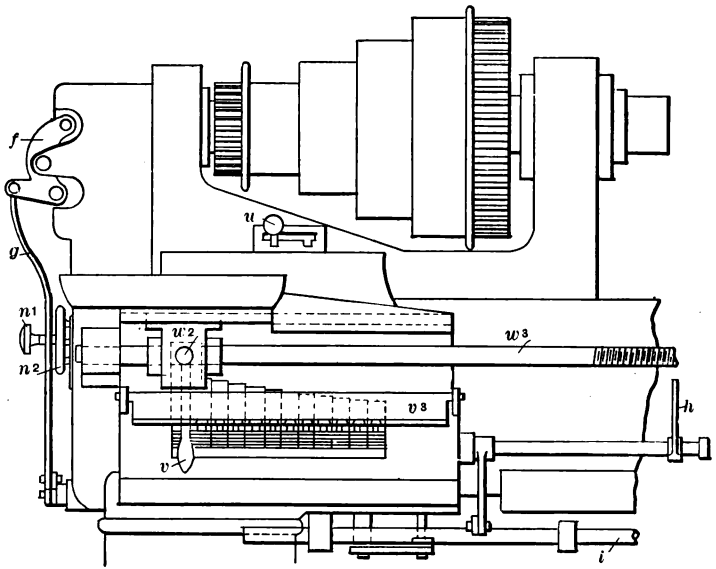


FIGURE 1.

The Derry Collard Co.

William A. Wood. No. 715,921, Dec. 16, 1902.

driving cone would not seem to commend itself to practical mechanics.

On December 16, 1902, William A. Wood, of Ansonia, Conn., was granted Patent No. 715,921, for an arrangement in which he employs the much used "cone of gears." He operates them in a manner different from that of his predecessors which we have noticed. The popular device heretofore shown has been that of a cone of gears with a connecting gear or pinion arranged to move longitudinally to any gear desired, and by a swinging movement to a position in mesh with it.

In the patent of Peter and William Shellenback, No. 468,383, dated February 2, 1892, the cone of gears is moved, as a whole, longitudinally to bring either of its members in mesh with the connecting gear or pinion, which swings forward to engage it. In Wood's patent the connecting pinion moves longitudinally until it is opposite the proper gear, when the cone of gears, as a whole, swings forward to engage it.

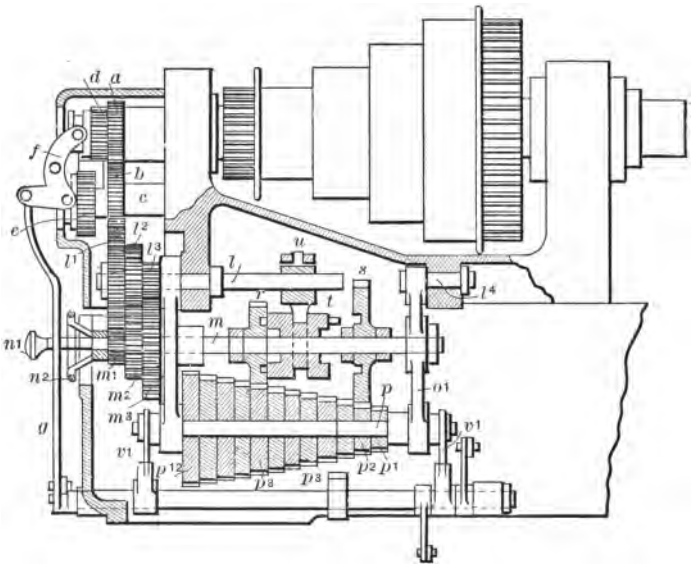
There is also the usual multiplying gears, individually connected by a sliding spline, in the ordinary manner; and an arrangement of reversing gears, operated either by hand, or, automatically by a rather complicated system of rock shafts, connecting rods, levers, etc., a number of the parts of which are not shown in the drawings.

The entire device is illustrated in the patent by twelve views, but its features essential to the subject herein discussed are shown in the four views herewith given.

The most serious objection to the device as a practical arrangement seems to be its complication, rendering it expensive to build and to adjust, and troublesome to

repair in case of the accidental breaking of any of its parts.

In the drawings, Fig. 1 is a front elevation; Fig. 2 is an end elevation of the head, with a vertical, cross section of the bed and connected parts. Fig. 3 is a longitudinal, vertical section, and Fig. 4 is a similar



The Derry Collard Co.

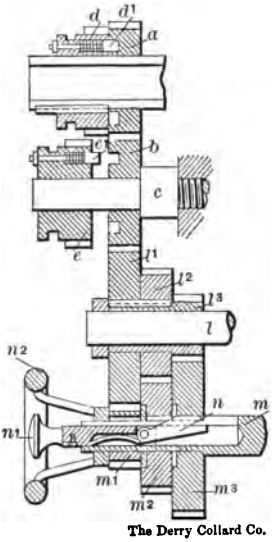
FIGURE 3.

William A. Wood. No. 715,921.

section on an enlarged scale, of the reversing and the multiplying gears. These make it quite clear.

Upon the main spindle is loosely mounted the gear *a*, always in mesh with the gear *b*, loosely mounted on the stud *c*. Upon the main spindle is also splined the clutch gear *d*, while a similar gear *e*, is loosely mounted

on the stud *c*. These clutch gears *d*, and *e*, are operated by the lever *f*, rod *g*, and their connecting parts, and may be operated by the hand lever *h*, or, automatically by the rod *i*, and its connecting parts, not fully shown. Upon the stud *j*, is loosely mounted the gear *k*, which is always in mesh with the clutch gears *d*, and *e*. These latter have



The Derry Collard Co.

FIGURE 4.

William A. Wood. No. 715,921.

spring pins d^1, and e^1, which fit in suitable openings in the face of the gears *a*, and *b*, connecting them when one or the other is moved forward by the clutch lever *f*. By this arrangement the motion of the whole train of gears below this point is readily reversed.

The multiplying gears l^1, l^2, and l^3, are rigidly connected to each other and loosely mounted on the stud *l*,

while their connecting gears m^1, m^2, and m^3, are loosely mounted on the transmitting shaft m, and connected thereto by means of the pivoted spline n, as shown in Fig. 4. The hand wheel n^2, is for convenience in turning the shaft m, to the proper position for connecting. By these gears three speeds are obtained.

Pivoted upon the studs l, and l^4, (Fig. 3), are the arms o, and o^1, in which the transmitting shaft m, is journalled, as is also the cone-of-gears shaft p, the latter having splined upon it the gears p^1, p^2, p^3, etc., forming the cone of gears "arranged in step-like form." The gears p^2, and p^8, of this series are always engaged respectively with the clutch gears s, and r, loosely mounted on the transmitting shaft m, and connected thereto by means of the clutch t, splined to it, and operated by the hand lever u.

By these gears two series of speeds are obtained, which, in connection with the series of multiplying gears, give six speeds, and with the twelve gears of the cone, give thirty-six speeds.

The arms o, and o^1, are controlled by the lever v, and its connection v^1, by which they are brought into a position to engage the transmitting gear w, meshing into the gear w^1, on the driven shaft w^2, when these gears have been brought to the desired position by means of the lever w^3, fixed in the sliding housing w^4. The lever v, is held in any desired position by the pivoted clamp v^8.

The line of motion may be easily traced from the main spindle to the lead screw.

Albert E. Newton, of Worcester, Mass., in Patent No. 728,279, dated May 19, 1903, shows an ingenious arrangement of the principle first shown by Carl J. Paulson in his patent, dated June 18, 1895, and numbered

541,385, in which the gears instead of being mounted on a shaft "in step-like form," are arranged "a number of rings one within another and of equal width, said rings capable of sliding laterally about one-half their width, more or less, to be exposed to that extent, and each having spur gear teeth cut on the part of the outer face that is so exposed when the ring is shifted from the normal position."

In this case, however, the form of the gears may be described as short cylinders, rather than rings, and they are not operated individually. They are not moved out to a position of action, but all gears outside of the one with which it is desired to connect are moved back, uncovering the desired gear.

Again, there are two sets of these gears, arranged facing each other on the same shaft, thereby increasing the number of possible changes, without rendering the device cumbersome or bulky.

The manner of operating the device is ingenious, but the mechanical difficulties of construction and fitting up some of the parts would seem to make it rather expensive to make and apply to a lathe.

In the drawings, Fig. 1 is an end elevation; Fig. 2 is a front elevation; and Fig. 3 is a horizontal section, on an enlarged scale, of the essential parts of the device.

Motion is transmitted from the main spindle to the usual reversing gears, *a*, *b*, *c*, and *d*, and the transmitting gears, e^1, e^2, and e^3. These latter may be replaced by gears of varying sizes when desired, to increase the number of possible changes.

Splined upon the driven shaft *f*, and successively upon each other, are the ring-gears *g*, g^1, g^2, g^3, etc., each composed of a cylinder, fitting over the next smaller one,

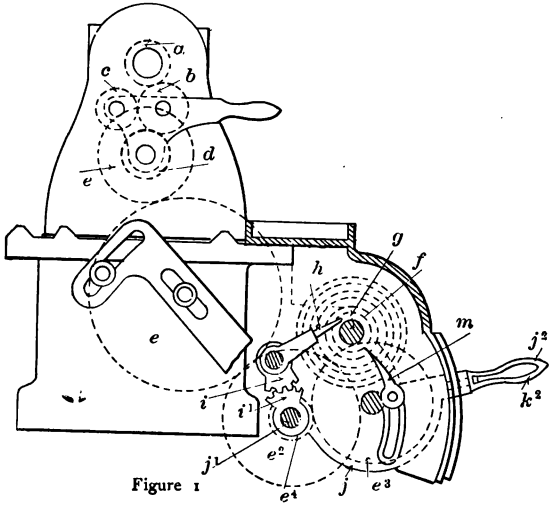


Figure 1

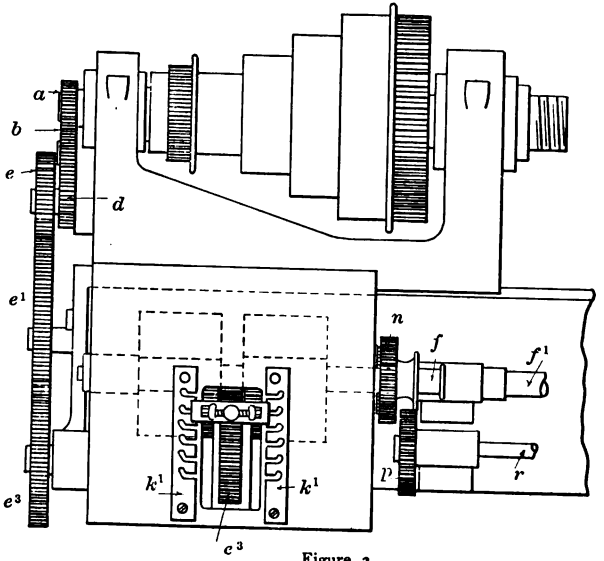


Figure 2

Albert E. Newton. No. 728,279, May 19, 1903.

and having gear teeth cut in the outer surface at one end. These gear teeth are arranged to mesh with those of the gear e^3, when it is moved longitudinally into position for that purpose, the latter, with the pinion e^4, being carried by the housing j, pivoted and sliding upon the shaft j^1, and having formed upon it the handle j^2, which is held in

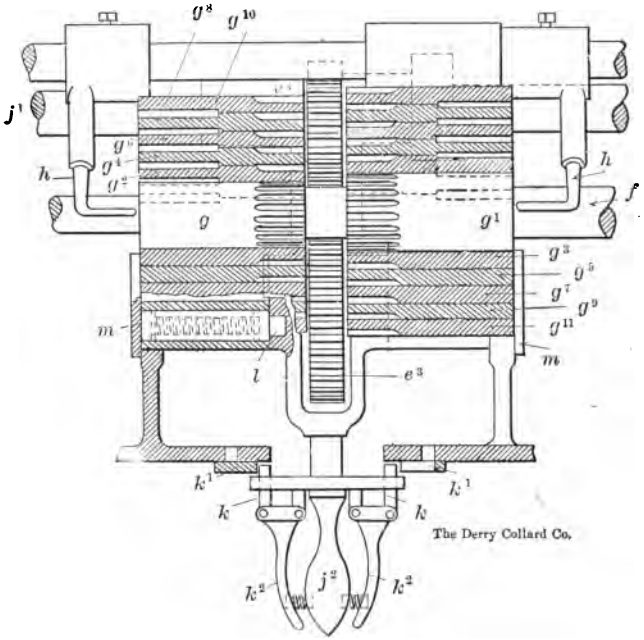


Figure 3

Albert E. Newton. No. 728,279, May 19, 1903.

position by the pins k, k, entering proper slots and locking holes in the plates k^1, k^1, and controlled by the thumb levers, k^2, k^2. These are alike on each side.

The keys of the gears g, g^1, g^2, etc., are fixed in

the outer gear and slide freely in the keyway of the next smaller gear. By this means the outside gears can be moved back out of the way so as to expose the teeth of any desired gear and enable them to be engaged by the teeth of the gear e^3. The inward motion of the ring gears g, g^1, g^2, etc., is limited, and when any one of these gears is moved back to its normal position it will carry with it all of the gears fitted inside of it.

The housing j, carries with it the gear e^3, and the pinion e^4, and by this means they may be shifted laterally and swung up into different positions between the two nests of ring gears to bring them into position, so that when so shifted laterally the gear e^3, will push back out of the way the ring gears outside of the gear with which connection is desired.

In order to prevent the ring gear into which it is desired to mesh the gear e^3, from being carried back as the outside gears are pushed back out of the way, the end fingers h, h, are provided, and are operated by the toothed segments i, and i^2, as shown in Fig. 1.

To restore the ring gears to their normal position the housing j, is moved back to the central position, being provided on each side with pins l, (shown only on one side in Fig. 3), having bushings operated by spiral springs, and provided with fingers m, m, which engage the rear faces of the ring gears g, g^1, g^2, etc., and bring them to their places.

A sliding pinion n, on the driven shaft f^1, meshes into a similar one on the lead screw f, or may be brought into mesh with the pinion p, on the feed rod r, in the usual way.

Conclusion

Having now described in detail the various patents up to a quite recent date, comparing them with each other, and having traced as clearly as may be the evolution of the change gear, it seems proper to offer some observations in the form of a summary of what has been presented.

The predominating features of all these various methods of producing a variable feed or a number of pitches of thread cutting, is the use of the "cone of gears," or a collection of gears arranged on a shaft "in step-like form." The second feature is that of providing, in connection with the cone of gears, two or more pairs of gears, which may be termed multiplying gears, each two pairs multiplying by two the number of changes produced by the cone of gears, or dividing in the same ratio the speeds already attained.

By multiplying gears is meant, pairs of small gears, usually a larger and a smaller on each of two shafts, say of 24 and 48 teeth, which may multiply or divide the speed by two. These may be used with gears of equal size, for instance with the above numbers of 24 and 48 teeth the equal gears may each have 36 teeth.

When used in connection with the cone of gears, they multiply the changes given thereby, as for instance, if the cone is of seven gears, the number of changes is readily made fourteen, twenty-one or twenty-eight.

A radical departure from these methods was made, first by Edward Flather, April 2, 1895, and Benj. F.

Burdick, April 23, 1895, and later by Wm. L. Shellenback, December 5, 1899, and in another patent, February 5, 1901, and by Herman R. Isler, October 15, 1901, and July 15, 1902. This consisted of arranging the series of various sized change gears on a circular disk, and usually around a central gear from which any one of them was operated, or by which the motion was communicated to the lead screw.

In the later patents they are arranged in an eccentric form so that only the pair needed at the time will be in action. It is doubtful, however, if either of these devices will come into general use, owing to the large number of parts, the complication and expense which they involve, as well as the difficulty of operating them by the average grade of machinists who might be called upon to use them, and the danger of breaking the gear teeth.

The one inventor who departed from all the usual forms on which others had seemingly rung all possible changes was Carl J. Paulson, June 18, 1895, who adopted a series of toothed rings, one within the other, which are engaged by a swinging pinion when any desired ring is moved out to its active position.

Paulson's idea was elaborated by Newton, in his patent of May 19, 1903, and put into a very practical form.

It is a somewhat remarkable fact that with the exception of the first claim of Bancroft and Sellers, 1854, all the claims in the twenty-nine patents herein discussed, are what is known as "combination claims," and that in all the two hundred and fifty-eight claims in this series of patents the devices and arrangements are often so near a counterpart of some prior patent that the delicate points of decision upon them in the Patent Office must have been

a hair-splitting process, governed more by the exact and carefully worded phraseology of the claims than the difference in the ideas of the inventors for those of former patents.

Bancroft's claim, referred to above, is this: "The method of varying the motions of the mandrel (head spindle), and screw shaft, or leader, by means of two series of wheels, each series consisting of wheels of different diameters, and all the wheels of one series being connected and turning together, and imparting motion to all the wheels of the other series with different degrees of velocity, substantially as described." Inventors have been harping on that same string ever since.

It may be truly said that Edward Bancroft and William Sellers are the originators of the method of producing variable feeds for turning or thread cutting in a lathe by the use of the "cone of gears."

In these articles there have been twenty-nine patents considered, comprising all relating to this subject on file in the United States Patent Office up to August 12, 1902. The following is the entire list:

Edw. Bancroft and
William Sellers.....No. 10,491, February 7, 1854.
John Humphreys..... No. 83,774, November 3, 1868.
Frederick B. Miles..... No. 111,859, February 14, 1871.
William Bley.....No. 156,758, November 10, 1874.
Charles W. Riley.....No. 233,702, October 26, 1880.
Andrew Hyde..... No. 247,764, October 4, 1881.
George A. Gray, Jr.....No. 252,760, January 24, 1882.
Joseph Flather.....No. 462,481, November 3, 1891.
Peter Shellenback and
William Shellenback..No. 468,183, February 2, 1892.
Wendel P. Norton.....No. 470,591, March 8, 1892.

William Shellenback....No. 518,164, April 10, 1894.
Wendel P. Norton.....No. 519,924, May 15, 1894.
Salmon W. Putnam.... No. 525,863, September 11, 1894.
Edward Flather.....No. 536,615, April 2, 1895
Benjamin F. Burdick... No. 537,816, April 23, 1895
Carl J. Paulson..... No. 541,385, June 18, 1895.
Herbert L. Flather..... No. 592,966, November 2, 1897.
Ernest J. Flather.....No. 595,562, December 14, 1897.
Benjamin A. Wheeler...No. 602,924, April 26, 1898.
William L. Shellenback. No. 638,359, December 5, 1899.
William L. Shellenback. No. 667,406, February 5, 1901.
Edward A. Muller.....No. 679,568, July 30, 1901.
Herman R. Isler..... No. 684,432, October 15, 1901.
Herman R. Isler..... No. 684,433, October 15, 1901.
Herman R. Isler..... No. 704,645, July 15, 1902.
Richard K. LeBlond....No. 706,186, August 5, 1902.
William T. S. Johnson.. No. 706,665, August 12, 1902.
William A. Wood..... No. 715,921, December 16, 1902.
Albert E. Newton..... No. 728,279, May 19, 1903.

Of the twenty-nine inventions herein considered, sixteen, *viz.:* Bancroft and Sellers, Humphreys, Miles, Riley, Hyde, Joseph Flather, Peter and William Shellenback, Norton, William Shellenback, Herbert L. Flather, Ernest J. Flather, Wheeler, Isler, Le Blond, Johnson, and Wood, make use of the "cone of gears" in various positions, combinations and methods of operation.

Of the sixteen inventors who use the cone of gears, there are ten, *viz.:* Humphreys, Miles, Hyde, Norton, Herbert L. Flather, Ernest J. Flather, Wheeler, Le-Blond, Johnson and Wood, who use the "traveler" and its connecting pinion to operate the intermediate shaft at its variable speeds.

As to the location of the cone of gears, Humphreys

and Johnson put it in the head; Bancroft and Sellers, Miles, Riley, and Hyde, place it at the end of the head.

Peter and William Shellenback, Herbert L. Flather, Ernest J. Flather, Isler, LeBlond, and Wood, locate it in the bed.

Ernest J. Flather forms a space in the front of the bed to accommodate the cone of gears.

Norton puts the cone of gears in a box in front of the bed.

Wheeler puts two cones of gears at the end of the bed, and one cone of gears in the apron.

Isler puts two cones of gears in the bed and four more at the back of the bed.

Of the methods of operating the cones of gears, eleven of the inventors fix the cone of gears on the shaft.

Bancroft and Sellers have one cone of gears loose on the shaft and connected by a removable pin, while the other cone of gears is fast to the shaft.

Riley, Joseph Flather, Wheeler, and Isler, use sliding keys.

Johnson fixes his cone of gears on a sleeve, loose on the head spindle.

Peter and William Shellenback have their cone of gears slide on the shaft in order to bring the gears successively into engagement with the connecting pinion.

Wood places his cone of gears in a swinging frame, and swings it into engagement with the connecting pinion.

Isler uses no less than six cones of gears, while Wheeler employs three. The fewer the better.

In the twenty-nine patents herein illustrated and described there are two hundred and fifty-eight claims.

Wood leads all the others in this matter, with thirty-three claims, while Wheeler is a close second with thirty.

One hundred and sixty-four patents.

Peter and William Shellenback have twenty-one claims, and William L. Shellenback has seventeen.

Putnam, and William L. Shellenback (1901), each have fifteen claims.

Miles is the most modest in his pretensions, making only one claim, while adding quite as much to the then "state of the art" as some of his later competitors.

Wheeler easily "takes the cake" in his specification, with its seven printed pages of erudite composition rivalling a Ralph Waldo Emerson lecture.

The examination of all the mass of Patents, amounting to one hundred and sixty-four, the selection of those particularly relating to the change gear devices, and the efforts to reduce them to their mechanical requisites have been a long and tedious work. That it is not perfect no one knows better than the author. That it may be of some assistance to conscientious investigators of the important mechanical devices of which it treats is the earnest wish of the writer of these pages.

Contents

Analyzing Patents, ... 8
Archimedes Screw—287 B. C., ... 12
Author, Portrait of, ... Frontispiece
Bancroft, Edward—1854, ... 22
Berson, Jacques—1569, ... 12
Bley, William—1874, ... 27
Burdick, Benjamin F.—1895, ... 43, 76
Chain Feed, ... 19
Change Gears, ... 15, 21, 47
Clutches, ... 27, 38, 41, 42, 50, 53, 54, 55, 60, 66, 67
Clutches—See Pin Clutches. . . .
Combination Claims, ... 74
Commercial Value, ... 7, 9
Conclusions, ... 73
Cone of Gears, 22, 23, 25, 28, 30, 31, 32, 33, 34, 36, 37, 39, 40, . 45, 46, 48, 50, 56, 60, 62, 63, 73, 75
Developing a Screw Thread, ... 16
Disk of Gears, . . . 42, 43, 52, 53, 55, 57, 59
English or Metric Threads, ... 41
Faulty Patent Drawings, ... 8
Feathers—See Keys. . . . .
Flather, Edward—1895, ... 42
Flather, Joseph—1891, ... 32
Flather, Herbert—1897, ... 46
Flather, Ernest J.—1897, ... 48
Fox Lathe, ... 13
Gears at End of Head, ... 22, 25, 28, 30
Gears in Bed, ... 34, 46, 48, 56, 60, 63

Contents.

Gears in Box at Front of Bed, ... 36
Gears in Carriage Apron, ... 50
Gears in Head, ... 23, 62
Gear Plate, Revolving, . . 42, 43, 52, 54, 55, 57, 59
Germ of Inventions, ... 8
Gray, George A., Jr.—1882, ... 31
History of Lathe, ... 10
Humphreys, John—1868, ... 23, 36
Hyde, Andrew—1881, ... 30, 36
Inaccurate Patent Drawings, ... 8
Isler, Herman R.—1901, ... 56. 57, 59
Johnson, William T. S.—1902, ... 62
Keys, Sliding, . . . 29, 50, 55, 57, 58, 59, 63, 67
Lantern Pinion, ... 19
Lathe History, ... 10
Le Blond, Richard K.—1902, ... 60
Machinery, Reference to, ... 5
Maudslay, Henry—1794, ... 12
Metric or English Threads, ... 41
Miles, Frederick B.—1871, ... 25, 36
Moxan, Joseph—1680, ... 12
Muller, Edward A.—1901, ... 55
Multiplying Gears, ... 67, 73
Newton, Albert E.—1903, ... 68
Norton, Wendell P.—1892, ... 36
Norton, Wendell P.—1894, ... 39
Patentees, ... 75, 76
Paulson, Carl J.—1895, ... 45, 68, 74, 76
Pin Clutches, ... 22, 29, 30, 42, 66
Pin Gears, ... 19
Pioneers—Bancroft and Sellers, ... 22
Pliny, ... 11
Potter's Wheel, ... 11

Contents.

Portrait of Author, ... Frontispiece
Predominating Features, ... 73
Preface, ... 5
Putnam, Salmon W.—1894, ... 40
Radical Departures, ... 74
Revolving Gear Plate, . . 42, 43, 52, 53, 55, 57, 59
Riley, Charles William—1880, ... 28
Ring Gears, ... 45, 68
Robinson, Anthony—1783, ... 16
Screw Threads, First, ... 12
Sellers, William—1854, ... 22
Shellenback, Peter—1892, ... 34, 65
Shellenback, William—1892, ... 34, 65
Shellenback, William—1894, ... 37
Shellenback, William—1899, ... 52
Shellenback, William—1901, ... 53
Splines—See Keys. . . . . .
Spring Pole for Lathes, ... 11
Traveler and Pinion, . 23, 25, 30, 36, 46, 48, 50, 60, 62, 63
Theodorus of Samos—560 B. C., ... 11
Wheeler, Benjamin A.—1898, ... 50
Wood, William A.—1902, ... 63